A star *) indicates that the Abstract deals with Apparatus and Instruments.

JUNE, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

1684. Isotopic weights of C and N by doublet method. T. ASADA, T. OKUDA, K. OGATA AND S. YOSHIMOTO. *Phys. Math. Soc., Japan, Proc.*, **22**, *pp.* 41–45, *Jan.*, 1940.—The value of ^{12}C, 12·003 94 ± 0·000 18, now obtained by the present authors with a newly constructed mass-spectrograph of the Bainbridge and Jordan type and using the doublet method, is slightly different from that of Aston, 12·003 55 ± 0·000 15, whereas the value of ^{14}N is in accord with previous data. Full details of experimental procedure are included in the paper. H. H. Ho.

1685. Isotope separation by transient pressure diffusion. E. J. HELLUND. *Phys. Rev.*, **57**, *pp.* 743–744, *April* 15, 1940.—The separation of molecules of nearly equal masses is investigated in connection with the Loschmidt experiment. The results are obtained by a perturbation treatment of the continuity equations for a ternary mixture. [See also Abstract 1703 (1940).] AUTHOR.

1686. Efficiency of thermal diffusion process for separating isotopes. J. W. WESTHAVER AND A. K. BREWER. *J. Chem. Phys.*, **8**, *pp.* 314–316, *April*, 1940.—The mechanism proposed by Gillespie [see Abstract 3110 (1939)] for the thermal separation of gases is correlated with the attendant conduction of heat; this is done by describing gaseous heat conduction as a heat exchange between two oppositely bombarding Maxwellian groups which differ in temperature at each isothermal surface by a finite ΔT. The resulting formulae enable a computation of ΔT the bombardment "equipartition distance" and the transport yield. An ideal system of cells each having temperature limits of 300°K. and 500°K. is found to require a minimum of 880 kWh of conducted heat per gm. of $C^{13}H_4$ extracted to a concentration of 20%. AUTHORS.

1687. Present state of valency theory. L. E. SUTTON. *Chem. Soc., J.*, *pp.* 544–553, *April*, 1940.—Reviews the progress which has been made in valency theory since the discovery of the electron and of the nuclear atom, the development of Bohr's theory of atomic structure, and recently of the Heisenberg and Schrödinger systems of wave mechanics. To assess the present state of our understanding, the lecturer first considers what would be expected of a complete and satisfactory valency theory, and the following parts of the subject are dealt with: (1) The complexity, i.e. whether the molecule exists as the lowest possible unit, a small polymer, or a "giant molecule". (2) The characteristic energies of electronic, vibrational, or rotational excitation, including the energy evolved when the molecule is formed from normal atoms. (3) The interatomic distances, the spatial arrangement of the atoms, the moments of inertia, and the molecular volume. (4) The force constants for vibrational movements in the molecule. (5) The electrical and magnetic properties such as the permanent electric and magnetic dipole moments, the deformability by electric and magnetic fields, usually called the polarizability and the diamagnetic susceptibility, and the anisotropy of these latter properties. The most important general contribution which wave mechanics has made to chemistry is the conception of resonance and this subject is discussed in great detail especially with respect to the covalent bond. It is concluded that abnormalities arise: (1) in a bond from changes in the hybrid character of the orbitals used for covalency formation, without change of bond order, or by resonance between a covalent structure and an ionic one, or by change in bond order; (2) in a molecule as a whole from resonance between different Lewis-Langmuir structures. H. H. Ho.

1688. Quantum-mechanical treatment of molecular ion HeH^+. S. Toh. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 119–126, *Feb.*, 1940.—The molecular ion HeH^+, whose existence and process of formation has been investigated experimentally by mass-spectrographic analysis, is the simplest of the stable heteronuclear diatomic molecules. Its structure was investigated theoretically by Beach, using modified atomic orbitals, and 0·5 eV was obtained as the lower limit of dissociation energy, whereas 0·8 eV was found by Coulson and Duncanson as the lower limit with a probable value of $1{\cdot}0 \sim 1{\cdot}5$ eV. In the present paper the method of James and Coolidge has been applied to this ion, and the investigation has been extended on the theoretical side. The best value of E_D calculated is 1·28 eV and is the highest hitherto obtained. The fundamental vibration frequency $\omega = 3\,400\ \text{cm}^{-1}$. is higher than that obtained by Beach, but is very close to the Coulson-Duncanson value of $3\,380\ \text{cm}^{-1}$., while the equilibrium internuclear distance 1·346 is considerably smaller than the values calculated by these authors, which is partly explained by the fact that the atomic orbital method gives a larger equilibrium internuclear distance than the variation in the general method. H. H. Ho.

1689. Bonding powers of groups of *d* electrons. W. G. Penney. *Faraday Soc., Trans.*, **36,** *pp.* 627–633, *May*, 1940.—The outstanding features of the bonding properties of *d* electrons were discovered by Pauling by means of the simple criterion of maximum overlapping of wave functions in conjunction with the directional properties of atomic orbitals. Van Vleck obtained Pauling's results by means of molecular orbitals and the crystalline field potential, and the present author now discusses a point which has previously been overlooked, viz. that the ions Ca^{++}. Mn^{++}, and Zn^{++} in aqueous solution, or in hydrated crystals, are in S states, while the other ions intermediate to them in the periodic table, are in D or F states. Now S states are not split up by crystalline forces, but D and F states are, the order of magnitude of the splittings being $20\,000\ \text{cm}^{-1}$. As a result, the ions in S states are not so closely bound to their water clusters as the other ions, the energy differences being about 30 kg.cal./mol. It is indicated that a plot of the energy against atomic number through the iron group sequence will show irregularities, Ca, Mn and Zn being about 30 kg.cal./mol. less stable than the others. A theoretical explanation is given from the bonding powers of groups of *d* electrons. H. H. Ho.

1690. Molecular structure of isobutane. J. Y. Beach and J. Walter. *J. Chem. Phys.*, **8,** *pp.* 303–305, *April*, 1940.—The two published electron diffraction investigations of isobutane led to slightly conflicting results. The authors have repeated the calculation of the theoretical scattering curves using $Z - F$ instead of Z for the atom form factor and including the temperature factor. The final results are: C–C distance, $1{\cdot}54 \pm 0{\cdot}02$ Å; C–C–C angle 111° 30′ ± 2°. Authors.

See also Abstracts 1696, 1732, 1744, 1791, 1830, 1869, 1923, 1924.

COLLOIDS.

1691. London-van der Waals forces between two disc-like particles. G. P. Dube and H. K. Dasgupta. *Indian Journ. Phys.*, **13,** *pp.* 411–417, *Dec.*, 1939.—The London-van der Waals interaction energy has been calculated between two disc-like particles. Only two cases are dealt with : (*i*) when the two discs are in the same plane, (*ii*) when their planes are parallel to each other but perpendicular to the line of centres. In the first case the interaction energy for small interparticle distances varies inversely as the 5/2 power of the shortest distance between the edges of the discs and in the second case it varies inversely as the quadratic power of the distance between their centres. These results may be used in explaining the arrangement of particles in thixotropic pastes. Authors.

1692. Micelle formation in aqueous solutions of digitonin. E. L. Smith and E. G. Pickels. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 272–277, *April,* 1940.—Ultracentrifugal observations using a direct-reading refractive index method have been made on aqueous solutions of digitonin. Practically all of the digitonin exists in the form of micelles of homogeneous size, with an average sedimentation constant of $5\cdot 88 \times 10^{-13}$ cm./dyne/sec. The micellar weight is likely to lie within the range of 75 000 to 400 000, as contrasted with a molecular weight of 1 228. Authors.

1693. Interpretation of simple electrophoretic patterns. L. G. Longsworth and D. A. MacInnes. *Am. Chem. Soc., J.*, **62,** *pp.* 705–711, *April,* 1940.—Electrophoretic studies of ovalbumin, at 0° and at *p*H 3·92, have been made by the moving boundary method. The research was undertaken in order to establish the conditions under which accurate values of protein mobilities may be found from moving boundary data. This involved investigation of the nature of the δ and ϵ boundaries, and of the concentration distributions in the rising and descending protein boundaries. The results indicate that, although in general more diffuse, the descending boundaries yield correct values of the mobility. The rising boundaries may give results that are greatly in error unless additional data are available from which corrections may be made, in which case the two types of boundary yield the same value of the mobility. Contrary to some recent conclusions, the mobilities have been found to vary but slightly with the protein concentration, if a small viscosity correction is made, within the composition limits studied. There is evidence that gradients of buffer concentrations exist, in general, in all the boundaries. The correctness of the interpretation has been indicated by showing, that, in certain cases, the δ and ϵ boundaries may be suppressed. Authors.

1694. Electrophoresis and diffusion constant of secalin. A. C. Andrews. *Am. Chem. Soc., J.*, **62,** *pp.* 942–948, *April,* 1940.—The prolamine of rye grain was prepared and purified by two different methods and certain of its physical constants were determined. The diffusion constant calculated to the water basis at 25° was found to be $4\cdot 78 \times 10^{-7}$ cm^2. per sec. (At 20°, $D = 4\cdot 3 \times 10^{-7}$ cm^2./sec.) A calculation by means of sedimentation methods, using this value of "D" and an estimated value of the sedimentation constant, gave a molecular weight for secalin of approximately 40 000. Thus the predominant constituent of secalin seems to belong in the egg-albumin molecular weight class of molecules. The ordinary isoelectric point for secalin as determined by electrophoretic mobilities was found to be at *p*H 6·67. Author.

1695. Apparent mutual repulsion of diffusion rings of $AgNO_3$ in gelatin. S. Veil. *Comptes Rendus*, **210**, *pp*. 434–435, *March* 18, 1940.—When two drops of the same solution of $AgNO_3$ diffuse through the same layer of gelatin close to each other, the rings of diffusing substance show an apparent repulsion, shown by a space in the gelatin which remains transparent. The phenomenon is modified when the gelatin contains dichromate, when the drops of $AgNO_3$ become the centres of systems of Liesegang rings. There is, however, a gap between the systems of rings, bordered by a thin red line. The distance between the edges of the gap is determined in relation to the distance apart of the drops. A. J. M.

1696. Application of viscosity data to determination of shape of protein molecules in solution. J. M. Burgers. *K. Ned. Akad. Wet., Proc.*, **43**, 3, *pp*. 307–315, 1940. *In English*.—The way in which the formulae for the viscosity and for the frictional coefficient have been applied by Polson to suspensions of proteins [see Abstract **3491** (1939) and *Nature*, **137**, *p*. 740 (1936)] and the discrepancy found between certain calculated and observed values, are discussed in this paper. In addition, data are also supplied for some cases not treated in previous work, viz. for disc-shaped particles (oblate rotational ellipsoids), and for certain systems consisting of rigidly connected spheres. It is found that the hypothesis of a large increase of volume in consequence of hydration does not help to remove the discrepancy between the results of the sedimentation and the viscosity measurements, so long as the assumption of an elongated ellipsoidal form is retained, and other shapes are under consideration. H. H. Ho.

See also Abstracts **1704**, **1733**.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

1697. Vicinal arrangements in Ni-Mn alloys. S. Kaya and M. Nakayama. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp*. 126–141, *Feb*., 1940.—The transition between states of order and disorder in the Ni-Mn alloys has been investigated by attendant changes in specific heats, electrical resistance, magnetic saturation, paramagnetic susceptibility, thermal expansion, and thermo-electric force [see also Abstract 1388 (1932)]. Variations with temperature do not follow the courses shown by the Cu_3Au and Ni_3Fe alloys, the main difference being that in the cases now considered, a relatively large temperature band (600° ∼ 300°) exists within which no critical points appear to occur. No temperature hysteresis can be detected from the heating and cooling curves. The large increase of resistance with temperature as shown by ordinary ferromagnetic substances, has been observed up to the Curie point, while above it a small decrease occurs notwithstanding the high values of the specific heats or the propagation of the transition to disorder. To explain this behaviour, there is introduced the idea of a vicinal arrangement whose linear expansion is comparable with the free electronic paths of the conducting electrons. The fact that the ferromagnetic Curie point is always greater with increasing vicinal orders shows that the exchange energy of the atoms associated with the Curie point is strongly influenced by the vicinal arrangement. H. H. Ho.

1698. Single crystals of metaboric acid. H. Tazaki. *Hirosima Journ. Sci.*, **10**, *pp*. 37–54, *March*, 1940.—The author produced new single crystals of metaboric acid enough for Laue and rotating-crystal methods to be applied to them. Two kinds of single crystal (i.e. dimorphic) were found, the one belonging to the orthorhombic and the other to the monoclinic system. The properties of these new single crystals were examined by means of a microscope and by X-rays. [See following Abstract.] AUTHOR.

1699. Structure of orthorhombic metaboric acid, $HBO_2(\alpha)$. H. TAZAKI. *Hirosima Journ. Sci.*, **10**, *pp.* 55–61, *March*, 1940.—It has been found by the writer that the single crystal of orthorhombic metaboric acid is produced by heating boric acid in moist air at atmospheric pressure [see preceding Abstract]. Its structure is minutely examined on the basis of its rotation X-ray photographs. [See Abstract 1702 (1940).] AUTHOR.

1700. Structure and orientation of silver halides. H. WILMAN. *Phys. Soc., Proc.*, **52**, *pp.* 323–347, *May*, 1940.—An electron-diffraction study of the reaction of halogen vapours with the (111)-twinned Ag films prepared by condensation on hot rock-salt cleavage faces, and with similar films reduced to single-crystal structure by heat treatment is described. The persistence of the Ag twin spots and lines indicates that both types of diffraction are probably due to twinning alone and not to presence of crystal surfaces parallel to octahedral planes. Accurate determinations of the lattice constants give values identical with the X-ray value for normal pure bulk Ag. Graphite was used as the most suitable comparison standard. The Ag halides formed had the normal structures, although the chloride crystals were often, and the cubic iodide crystals always, twinned on (111) planes. Strong spots due to secondary scattering were present in many of the patterns. The lattice constants of the unchanged Ag and of the halide crystals were normal and substantially constant. Rapid attack by concentrated halogen vapour always yielded a randomly disposed layer of halide crystals. Slower attack by halogens diluted with air yielded halide layers with strong orientation relative to the original Ag lattice, even when complete conversion of the film to halide resulted. [See Abstract 2750 (1939).] N. M. B.

***1701. Generalization of Bragg-de Broglie method of focusing in double-crystal X-ray spectrographs.** H. T. PLASENCIA. *Comptes Rendus*, **210**, *pp.* 395–398, *March* 11, 1940.—Conditions under which a double-crystal X-ray spectrograph can be focused without the use of a collimator, by the movement of the crystals are discussed. A. J. M.

See also Abstracts 1702, 1850, 1935, and

907B Constitution of Al-Zn Alloys above 275°C. New high-temperature X-ray camera. E. C. Ellwood.

DENSITY.

1702. Changes of density of metaboric acid on heating. H. TAZAKI. *Hirosima Journ. Sci.*, **10**, *pp.* 63–71, *March*, 1940.—Two kinds of metaboric acid crystals, orthorhombic $HBO_2(\alpha)$ and monoclinic $HBO_2(\beta)$, were produced [see Abstract 1698 (1940)]. In the present experiment the changes of density of both metaboric acids under heating, and the vapour pressures of the systems composed of each metaboric acid and its dissociated substances, were observed. The processes by which each metaboric acid is converted into boric anhydride are here discussed on the basis of these data.

DIFFUSION AND OSMOSIS.

1703. Osmotic diffusion in gases. E. J. HELLUND. *Phys. Rev.*, **57**, *pp.* 737–742, *April* 15, 1940.—The theory of diffusion induced in a " solvent " gas, by the pressure diffusion of two other gases, is developed on the basis of formulae derived in a previous paper by the author [see Abstract

971 (1940)]. The analysis is applied to the Loschmidt experiment and the pressures generated, are found analytically as a function of the time elasped, from the onset of diffusion. All formulae are given in terms of the binary diffusion coefficients of the component gases. [See also Abstract 1685 (1940).] AUTHOR.

1704. Permeability of organic polymers. R. M. BARRER. *Faraday Soc., Trans.*, **36**, *pp.* 644–648, *May*, 1940.—Data are given for the permeability of membranes of bakelite, ebonite, polyethylene, and cellophane to the gases He, H_2 and N_2 over the range 17 to 85°C. From the temperature coefficients, values of E_1 are obtained for the expression $P = P_0 e^{-E_1/RT}$ (P denotes the permeability constant). The results are discussed in terms of the theory of non-specific activated diffusion through rigid membranes, and are related to previous data on rubber-like and cellulosic membranes. [See Abstract 2310 (1939).] AUTHOR.

1705. Size of pores in paper. F. T. CARSON. *Bureau of Standards, J. of Research*, **24**, *pp.* 435–441, *April*, 1940.—The various methods which have been used to determine the size of pores in paper are briefly reviewed. These are of three general types: (*a*) methods based on rate of efflux of fluids; (*b*) methods based on rate of rise of liquids in vertical strips; (*c*) methods based on the capillary pressure involved in penetration by liquids. A new method is outlined, which takes advantage of the fact that the coefficient of slip of air in viscous flow through paper is a function of pressure. From the Meyer equation, the average effective pore radius is evaluated in terms of the air permeability values at two pressures. It is only necessary to determine the air permeability at two different pressures of an identical area of paper. Experimental values for two such air-permeability determinations on each of five papers, and the resulting values calculated for the average effective pore radius, are tabulated. AUTHOR.

See also Abstracts 1685, 1686, 1695, 1707, 1768.

ELASTICITY AND PLASTICITY.

1706. Distribution of stress in a thin stiffened elastic sheet. E. REISSNER. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 300–305, *April*, 1940.—An integral equation is derived for the distribution of the stresses arising when a concentrated force is applied to a flat sheet by means of a stiffener. It is seen that the equation is a generalization of one occurring in the theory of aerofoils of finite span. It is shown to be simpler to solve the inverse problem of determining the stiffener sizes for a prescribed stress distribution than to determine the stresses for given dimensions of the structure. It is proved that for constant cross-sectional area of the stiffener the stress distribution depends only on two dimensionless parameters composed of the six independent dimensions and moduli of elasticity occurring in the problem, and that for an infinite stiffener length only one parameter remains. The method of analysis here presented is, of course, applicable to more general cases. If, for instance, a sheet with several stiffeners is considered, a system of simultaneous integral equations is obtained instead of the single equation. AUTHOR.

1707. Grüneisen's constant for incompressible metals. J. C. SLATER. *Phys. Rev.*, **57**, *pp.* 744–746, *April* 15, 1940.—Grüneisen's constant γ can be determined in terms of the thermal expansion, compressibility and specific heat, as originally shown by Grüneisen. It can also be found from the compressibility and change of compressibility with pressure.

Theoretically the two methods should give approximately the same result. This has proved to be the case experimentally, except for the more incompressible metals, where the discrepancies have been very great. Bridgman has now redetermined the change of compressibility of iron with pressure, obtaining a much smaller value than before, and as iron was used as a standard, this brings about a revision of other changes of compressibility with pressure, largest in proportion for the incompressible metals, whose volume change is about the same as for iron. It is shown that this revision is just enough to bring the two methods of finding γ into agreement, for practically all the metals. AUTHOR.

***1708. New method for measuring Young's modulus.** A. KING. *Rev. Sci. Instruments*, **11**, *pp.* 114–116, *April*, 1940.—The specimen, in the form of a circular loop of wire, is fastened at one point to a rigid support. At the diametrically opposite point a magnetic field is applied. The frequency of an a.c. in the loop is adjusted until flexural vibrations occur in the plane of the loop. Then the resonance frequency f, the radius of the loop r, the linear density m, and the radius of the wire a are related to Young's modulus by the equation $E = 18{\cdot}395\ mf^2(r/a)^4(1 - g)$ in which $(1 - g)$ is a gap correction factor. AUTHOR.

1709. Phenomena of interference of curves of vibration. J. W. N. LE HEUX. *K. Ned. Akad. Wet., Proc.*, **41**, 4, *pp.* 387–394, 1938, *and* **43**, 1, *pp.* 57–65, 1940. *In French.*—Continuation of previous work. [See Abstract 1299 (1930).]

1710. Forced vibrations of a strained rectangular plate. S. IGUCHI. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp.* 1–14, *Jan.*, 1940. *In German.*—This entirely mathematical paper discusses the normal, forced and resultant vibrations of a thin flexible rectangular plate subjected to strain on all sides. H. H. HO.

1711. Effect of sustained loading on breaking strength of sheet glass. A. J. HOLLAND AND W. E. S TURNER. *Soc. Glass Technol., J.*, **24**, *pp.* 47–57, *Feb.*, 1940.—The effect of sustained loading on the modulus of rupture of specimens of sheet glass having ground and well-polished edges and of dimensions 10 × 0·8 × 0·275 cm. has been determined by loading the specimens to the extent of 100, 90, 80, 70, 60, 50, 40 and 30% of the previously determined mean breaking load and measuring the time interval between loading and fracture. For loads equal to or greater than 70% a number of specimens fractured before the full load was reached. For loads less than 70% some of the specimens remained unbroken after 1 000 hours the number unbroken increasing as the load decreased until all the specimens remained unbroken after 1 000 hours at the 30% load. For those specimens fracturing it was found that a straight-line relationship held between the logarithm of the mean breaking time and the logarithm of the applied stress. A factor of safety of not less than four was suggested for sheet glass of the type described. AUTHORS.

See also Abstracts 1938, 1939.

GRAVITATION.

1712. Gravity and rotation of the earth. C. G. PENDSE. *Phil. Mag.*, **29**, *pp.* 471–476, *May*, 1940.—The axes of reference for the motion of the members of the solar system, to which the law of gravitation applies, have for their origin the "centre of mass" of the system and their directions are towards the "fixed" stars. In problems of terrestrial mechanics, however, the observations of position refer to axes whose directions are fixed relative to the earth and whose origin is either on or above and near the surface of the earth. The successive steps by which one can obtain the equations of motion of a body (particle), valid for the frames of reference suitable for terrestrial mechanics, are shown. The combination of the centrifugal acceleration with the gravitational intensity due to the earth gives rise to the " acceleration due to gravity ", the equation being transformed into one in which the value of the quantity at the *origin* of the frame is involved. Furthermore, the mutual relations between the different terrestrial frames are pointed out. AUTHOR.

1713. Earth's crust deformation in the East Indies (Provisional Paper). F. A. V. MEINESZ. *K. Ned. Akad. Wet., Proc.*, **43**, 3, *pp*. 278–293, 1940. *In English*.—For further investigation of the results of the gravity expeditions with submarines of the Netherlands navy new tables for regional isostatic reduction have been prepared. The system published in the *Bulletin géodésique*, No. 29, 1931, has been applied to give different degrees of regionality. Details of the method are given. The tables have been made for five different values of l, i.e. 10, 20, 40, 60 and 80 km. corresponding to values of the outer boundary t of 29·05, 58·10, 116·20, 174·30 and 232·40 km. In the fundamental tables the compensation has been assumed to be distributed uniformly over a depth H below sea level and the tables comprise all values of H from 0 to 60 km. From these tables others have been derived for practical use in which the compensation extends from a depth of 30 km. to a depth of $30 + 4{\cdot}45\,s$, where s is the height of the topography above sea level. The new tables adopt the system of hydrostatic equilibrium of the crust but assume the root at the lower boundary of the crust to be broader according to a bending of the crust, instead of its sinking locally under the load of the topography. Some conclusions derived from the results of these reductions for the East Indies are given. Later maps of the anomalies and a great many profiles for all the values of l are to be published and a comparison can be made. R. S. R.

HYDRODYNAMICS AND AERODYNAMICS.

1714. Application of model system in statistical theory of free turbulence. J. M. BURGERS. *K. Ned. Akad. Wet., Proc.* **43**, 1, *pp*. 2–12, 1940. —The author has previously described some mathematical models by which several features of turbulent motion can be illustrated. These models serve principally to illustrate the development of a dissipative secondary motion. The conception of correlation, as discussed by Taylor and v. Kármán, and equations describing the decay of free turbulence are now treated, and properties of the model system which are operative in the propagation of elementary regions of turbulence are considered in more detail. J. S. G. T.

1715. Flow between smooth parallel walls and through smooth pipes. T. OKAYA. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp*. 146–161, *Feb.*, 1940.—A theoretical discussion of fluid flow between smooth parallel walls and through smooth circular pipes is presented. In the theory the velocity $U(r')$ at the point r' is defined by a special function $\theta(r')$ such that $[U_c - U(r')]/\overline{U} = \Lambda\theta(r')$, where U_c is the maximum velocity of flow, $\overline{U}$ the mean velocity, and $\Lambda = 0{\cdot}6797 - 0{\cdot}07323 \log R$, where R is the Reynolds number. J. S. G. T.

1716. Hydrodynamical images. L. M. Milne-Thomson. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 246–247, *April*, 1940.—It is shown that to find the disturbance due to placing a cylinder of any form of section in a field of 2-dimensional irrotational flow it is necessary only to determine the conformal representation which maps the region exterior to the contour of the section on the region exterior to a circle C. The special case of a circular cylinder typified by its cross-section, the circle C, $|z| = a$ is fully discussed. The method can be applied to the 2-dimensional aerofoil, e.g. to determine the effect of the lower plane upon the upper plane of a biplane. J. S. G. T.

***1717. Flow meter for slow flow.** A. E. L. Marsh. *Faraday Soc., Trans.*, **36**, *p.* 626, *May*, 1940.—A new type of flow meter is described which is independent of the viscosity of the gas for which it is used. Author.

See also Abstract 1705.

KINETIC THEORY OF MATTER.

1718. Present condition of kinetic theory of liquids. Y. Rocard. *Rev. sci., Paris*, **78**, *pp.* 11–16, *Jan.*, 1940.—The author first shows mathematically that the classical kinetic theory of gases can account for the equation of state of ordinary liquids and for surface tension. The kinetic theory, however, does not explain clearly the enormous diminution in viscosity for the majority of liquids with rise in temperature; here some degree of organization in the liquid would appear to exist, and this is in contradiction with the hypothesis of molecular chaos. Similar difficulties arise in connection with thermal conductivity and specific heat. H. H. Ho.

1719. Brownian motion and Einstein's formula. M. J. Duclaux. *J. de Physique et le Radium*, **1**, *pp.* 81–84, *March*, 1940.—The problem of the Brownian motion of a particle in a viscous liquid has hitherto been considered as solved by the Einstein formula. The latter, however, results from a combination of the principle of equipartition of energy and hydrodynamics, and takes no account of the molecular nature of the liquid. It is not therefore, in reality, a formula of the Brownian motion, but a particular case of a general law according to which the average trajectory of a particle, or its average position of equilibrium, is independent of the presence and of the nature of the liquid environment. The true expression for the Brownian motion is that which will give the viscosity of a liquid as a function of its molecular constitution. The experimental data derived *via* the Einstein formula are thus incomplete and do not permit exact conclusions to be drawn. H. H. Ho.

See also Abstract 1686, 1830.

MASS.

See Abstract 1725.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

1720. Formulations of an experimental law. P. Vernotte. *Comptes Rendus*, **210**, *pp.* 475–477, *March* 27, 1940.—Continuation of a previous paper [see Abstract 1405 (1940)] in which it was shown how to combine in the best way by a theoretical curve a distribution of experimental points by identifying the *mean value* of the theoretical and the experimental function in the midst of as many of the regions called fundamental as there are of parameters in the theoretical law. (1) The theoretical law being taken under the form $M + d[(Ax + B) : (x^2 + Cx + D)] : dx$ it is shown how to calculate the 5 coefficients M, B, C, D, A. (2) The *mean values* of the experimental function are then calculated. By Lagrange's interpolation formula the polynome of degree $(n - 1)$ passing through n successive experimental points is determined, and hence a *primitive function* is formed. Thus is calculated by successive bands the area of a fundamental region (comprising many groups of points) and from this is deduced the mean experimental value $\overline{y}$ obtained under the form of a linear and homogeneous function of the successive orders y_i. The orders equidistant from the extremities play the same part. (3) The calculation of a mean value is effected with different intervals by utilizing consecutive bands with a variable number of orders. Classically irregularity was set out by consideration of the successive differences, but this method is uselessly sensitive and the procedure proposed by the author brings into account only *means* which can *always* be calculated. J. J. S.

1721. Statistical theory of errors. (Progress of Astronomy Reports.) H. R. Hulme. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 303–314, *Feb.,* 1940.—The author treats the theory of the combination of observations from the statistical point of view, with special reference to astronomical problems. The problems considered are those of estimation, in which a series of observations is to be combined to give the best value to be adopted, and those of significance, where the reliability of an adopted value is to be assessed. The efficiencies of various methods of estimation are derived, and a " method of maximum likelihood " developed. Various properties of the Gaussian distribution are examined, and their sampling distributions obtained. The importance is emphasized of giving the number of observations on which a probable error is based, as a measure of its reliability. Problems of significance are discussed in relation to the various levels of significance, to " Student's " test, and to Pearson's χ^2 test. It is concluded that though we cannot in general state the probability that the true value of an observational quantity lies between certain limits, we can, whilst asserting that the true value is within a certain distance of the mean of a number of sample observations, so choose this distance that our assertion will be wrong only once in a stipulated number of times. A. Hu.

1722. Correction of statistics for accidental error. A. S. Eddington. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 354–361, *March,* 1940.—Attention is called to the invalidity of a procedure sometimes adopted in statistical investigations, especially in studying the distribution of stellar parallaxes. By a formula originally due to the writer, " improved values " of the parallaxes can be obtained with smaller mean square error. These are the best values to adopt for individual stars ; but, contrary to what is generally assumed, the frequency curve of the improved parallaxes is not usually a better approximation to the true frequency curve than the frequency curve of the uncorrected parallaxes. " Improved values " should not be used for any kind of statistical inquiry. The whole question gives an interesting sidelight on the arbitrariness of the conception of inverse probability. Opportunity is taken to supplement the author's earlier presentation of this formula and of another which is closely related to it. Author.

1723. Probable error for Poisson distributions. E. Rodgers. *Phys. Rev.,* **57,** *pp.* 735–737, *April* 15, 1940.—It is shown for Poisson distributions that both the probable error and the probability that a deviation not exceed the standard deviation approach as limits the corresponding values for normal distributions. Curves are given showing the manner of approach. AUTHOR.

See also Abstract
943B. Addition and subtraction logarithms. F. Addey.

MECHANICS, CLASSICAL.

1724. 3-body problem. C. DRAMBA. *Comptes Rendus,* **210,** *pp.* 131–133, *Jan.* 22, *and pp.* 393–395, *March* 11, 1940.—Mathematical. The double binary collisions of three bodies of mass m, m, and M, arranged at the apices of an isosceles triangle (*a*) in one plane, (*b*) in space, are considered. A. J. M.

1725. Mass and force in Newtonian mechanics—Addendum to "Mass I" and "Mass II". C. G. PENDSE. *Phil. Mag.,* **29,** *pp.* 477–484, *May,* 1940. —Further aspects relating to the definition and observational determination of mass in Newtonian mechanics are considered. Papers by Jeffreys, Filon and Narlikar and their methods are discussed and their differences from those of Mach and Pearson are stated. Jeffreys' method is similar, in general terms, to that outlined previously by the author [see Abstracts 5218 (1937) and 971 (1939)] but he did not consider the theoretical status of mass and force when the system under consideration is such that it is not possible to think of " quasi-isolated " systems of two bodies as a first approximation. Filon's criticisms of Mach's concept of mass are explained but it is considered that they neither prove nor disprove Mach's idea. Finally Narlikar's views and criticisms are examined. R. S. R.

MECHANICS, QUANTUM.

1726. Wave mechanics of certain twisted spaces. J. ROUBAUD-VALETTE. *Comptes Rendus,* **210,** *pp.* 168–169, *Jan.* 29, 1940.—Dirac's theory of the electron can be interpreted geometrically. The introduction of an electromagnetic field then corresponds to assuming a twisted space. R. P.

1727. Theory of the electric charge and the quantum theory. Part I. H. T. FLINT. *Phil. Mag.,* **29,** *pp.* 330–343, *April,* 1940.—As the association of wave and particle in the photon has been expressed in former theory by means of the null geodesic of the four-dimensional continuum of relativity theory, it is suggested that the electron might be similarly treated. This is found possible by employing a fifth dimension, which, though not so easy to interpret as the fourth dimension of ordinary relativity theory, may be considered as the co-ordinate conjugate to the charge, and analogous to the angular co-ordinate in the theory of atomic orbits. The tensor theory is developed, and it appears that the electric charge must be quantized in quanta inversely proportional to a length $l_0 = h/m_0C$, the Compton wavelength. The relation between energy and velocity of an electron is calculated. In studying the electron path in the absence of an electromagnetic field, an interval of proper time less than h/m_0C^2 has no significance. The effect of this result on the theory of atomic stability is considered and it is shown that atoms cannot exist with an atomic number exceeding 96. The introduction of other than electronic masses into the theory is considered, and it appears that some phenomena demand the introduction of a mass $= 137\beta$ times the ordinary atomic mass, where $\beta = v/c$. J. P. A.

1728. Type of elementary particle with wave-functions satisfying the Klein-Gordon equation. A. PROCA. *Comptes Rendus*, **210,** *pp*. 563–564, *April* 15, 1940.—The particles considered are defined, in the absence of an electromagnetic field, by two spinors one of rank 1, the other of rank 3 which satisfy linear equations. The latter, on iteration, become $\Delta V = \lambda^2 V$ where Δ is the 4-dimensional partial differential wave-operator. The electromagnetic potentials cannot, however, be introduced into the linear equations in the way used by Dirac. It is stated that a physical identification of such particles remains an unsolved problem. G. C. McV.

See also Abstract 1688.

PRESSURE.

***1729. Ionization gauge.** R. S. MORSE, R. M. BOWIE. *Rev. Sci. Instruments*, **11,** *pp*. 91–94, *March*, 1940.—An ionization gauge suitable for very low pressures—less than 10^{-6} mm. of Hg—has been designed. The electrical leakage to the plate must be very small; the connection between the bulb of the gauge and vessel must be short and of large diameter; the gauge must be easily degassed. The plate is in the form of a Pt film deposited on the wall of the bulb and is connected to an outer metallic ring. The absence of any protruding leads makes it possible to heat the bulb easily in the degassing process. A diagram and full details of the construction of the gauge are given. The sensitivity is high. The relation between plate current and plate voltage is linear between − 10 and − 40 V. The plate current also varies linearly with grid voltage throughout a range of 40 to 200 V. A satisfactory working grid voltage is 150 V for average operation. G. G.

***1730. Sensitive automatic pressure control device.** R. A. SMITH. *Rev. Sci. Instruments*, **11,** *pp*. 120–122, *April*, 1940.—An electronic resistance manometer has been developed which permits close regulation of vacua within the range of the Pirani gauge. AUTHOR.

See also Abstract 1893, and
978B. Piezo-electric measurement apparatus. P. K. Hermann.

RELATIVITY AND ETHER.

See Abstract 1727.

SOLUTION.

1731. Solubility of CO_2 in water from 12 to 40°C. and at pressures up to 500 atm. Critical phenomena. R. WIEBE AND V. L. GADDY. *Am. Chem. Soc., J.*, **62,** *pp*. 815–817, *April*, 1940.—The solubility of CO_2 in water has been determined at 12, 18, 25, 31·04, and 40° and at pressures up to 500 atm. Evidence of complete miscibility was found particularly in the low temperature range and an attempt was made to portray qualitatively the course of the critical curve. Solid-CO_2 hexahydrate was discovered at 10° at all pressures above 50 atm. and at 12° between 300 and 500 atm. AUTHORS.

1732. Solubility and molecular rotation of tetra-, penta- and hexa-substituted benzenes. C. P. SMYTH AND G. L. LEWIS. *Am. Chem. Soc., J.*, **62,** *pp*. 949–952, *April*, 1940.—The solubilities in benzene of 12 tetra-, penta-, and hexa-chlorine and methyl substituted benzenes have been measured at 4 temperatures. The solubilities are approximately ideal and are independent of the dipole moments of the molecules. The heats and entropies of fusion have been calculated from the slopes of the solubility curves. In accordance with the relation previously observed between molecular rotation in the solid and melting point, the solubilities and entropies of fusion tend to be low and the melting points high when the molecules possess freedom of rotation in the solid. AUTHORS.

1733. Solubility and swelling of high polymers in ternary mixtures. J. N. BRØNSTED AND K. VOLQVARTZ. *Faraday Soc., Trans.*, **36**, *pp.* 619–624, *May*, 1940.—The equilibrium in ternary systems containing polystyrene has been determined. As in binary mixtures one phase in the equilibrium is a swelled phase while the other consists of the pure medium. The experiments are compatible with the existence of ternary critical points. [See also Abstract 2362 (1939).] AUTHORS.

See also Abstract 1868, and
910B. Solubility of Mg in Al. G. Siebel and H. Vosskühler.

SURFACE PROPERTIES.

1734. Thermodynamic derivation of Langmuir's isotherm. G. S. RUSHBROOKE AND C. A. COULSON. *Cambridge Phil. Soc., Proc.*, **36**, *pp.* 248–251, *April*, 1940.—Langmuir's isotherm formula for immobile adsorbed films has already been derived by the methods of gas-kinetic theory and by the methods of statistical mechanics. It is now shown that the ideas implied in the Carnot cycle restrict the equation of an isotherm to a certain class of equations, of which Langmuir's is the simplest.

J. S. G. T.

1735. Monolayers on solids. I. LANGMUIR. *Chem. Soc., J.*, *pp.* 511–543, *April*, 1940.—Deals with adsorption at phase boundaries and with the nature of the adsorbed films. The nature of the forces first receives attention, and it is shown that for stable equilibrium attractive chemical forces and van der Waals forces, such as those that are involved in the liquefaction of CH_4 at low temperatures and are non-specific attractive forces, must be balanced by repulsive forces which prevent the interpenetration of electronic shells and keep the molecules from coming too close together. Cohesion and adhesion are now considered to be examples of such types of forces. The range of these forces is considered at length, following which comes a detailed description of experiments with W filaments in which it is shown that atoms of O or Th are bound firmly to the surface of the W filament, even at very high temperatures. This proves that the effective range of action of the forces is small even when compared with atomic diameters. In order to gain knowledge of adsorption by van der Waals forces, experiments are described for the adsorption of such gases as A, N_2, H_2, O_2, and CH_4 on plane surfaces of glass and mica, and a condensation-evaporation theory of adsorption on solids is discussed at length. The author opines that there is no case better adapted to a complete study of the mechanism of adsorption phenomena than that of the adsorption of Cs on W, since not only can the number of Cs atoms on the surface of the filament at any given time be measured accurately, but in the same apparatus the contact potential, the rates of evaporation of Cs atoms and ions and of electrons can be simultaneously measured as a function of the filament temperature and the number of adsorbed atoms per cm^2. From these data it becomes possible to calculate the forces acting between the adatoms, to measure the heats of evaporation, and to check these data against thermodynamic equations. The author next outlines the theory of adsorbed films as two-dimensional gases, following which comes the consideration of adsorption isotherms and equations of state for atoms having diameters greater than the shortest distances between sites. An equation of state for Cs adatoms on W is then derived, and a large diagram is included showing a typical arrangement of adatoms on a square lattice after partial equilibration. Although it would hardly be expected to find conditions for activated adsorption on powdered or porous substrates that conform for those postulated in the theory of adsorption on crowded plane lattices, nevertheless the hyperbolic isotherm, originally derived for plane surfaces, has often been found to apply well to powdered substrates. H. H. Ho.

1736. Gibbs relation and adsorption formulae. A. Boutaric. *J. de Physique et le Radium,* **1,** *pp.* 99–102, *March,* 1940.—The Gibbs relation, $u = -(c/iRT)(\partial\gamma/\partial c)$, where u = excess of concentration per unit area of surface due to adsorption, i = van't Hoff factor, c = concentration in interior, γ = surface tension, is deduced by a simple method. It is also shown that the relation between the decrease of surface tension, p, due to the presence of adsorbed molecules, and u, is of the general form $p = RTu/m$, m being unity when the adsorption obeys the Langmuir-Perrin formula. Various adsorption formulae are deduced theoretically, including those expressing the effect of temperature on adsorption and surface tension. A. J. M.

1737. Surface equilibrium of complex solutions. P. L. du Noüy. *Comptes Rendus,* **210,** *pp.* 334–335, *Feb.* 26, 1940.—When a trace of a surface active substance is added to any colloidal solution, there is a rapid fall in surface tension, immediately followed by a rise, depending on the concentration of the added substance. This effect, known as the du Noüy effect, has been investigated by means of the automatic registering apparatus for surface tension previously described [see Abstract 1018 (1940)]. The effect is found not to be confined to colloidal solutions, but is observed with a number of non-colloidal substances, whether ionized or not, e.g. glycerol and sugars in general. A. J. M.

1738. Surface tension of ethyl alcohol-water mixtures. W. S. Bonnell, L. Byman and D. B. Keyes. *Indust. and Engin. Chem.,* **32,** *pp.* 532–534, *April,* 1940.—The surface tensions of 8 ethyl alcohol-water mixtures (from 2·33 to 92·72% ethyl alcohol by weight) were determined at temperatures ranging from room temperature to the atmospheric boiling points of the various solutions. The surface tension decreased slowly with increase of temperature in linear relationship. At constant temperature the surface tension was found to decrease with increased concentration of alcohol, rapidly at first (up to 20–30% by weight) and then more slowly. Authors.

1739. Polish layers on Ni. P. E. Axon. *Phys. Soc., Proc.,* **52,** *pp.* 312–322, *May,* 1940.—Surface layers which give an electron-diffraction pattern of diffuse haloes have been produced on Ni, by (*a*) hand rubbing with emery, (*b*) rubbing a sample spinning in a lathe chuck with emery, and (*c*) firing a cylindrical Ni bullet into water, the diameter of the bullet being slightly greater than that of the rifling ridges of the revolver barrel. The depth and chemical composition of the smooth layers producing the diffuse haloes were determined, and results show that the abrasive action produces more than mere surface smoothing. The depth of the amorphous layers is a function of the amount of abrasion, and of the pressure perpendicular to the surface (very great in (*c*) above). Increasing the amount

V.4
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of abrasion increases the oxide content of the layer. The Bragg spacings of the diffuse haloes are compared with results obtained in other cases. E. E. W.

1740. Interfacial tension between polarized Hg and dilute H_2SO_4. F. Bon. *Comptes Rendus*, **210**, *pp.* 567–569, *April* 15, 1940.—The curves drawn between interfacial tension of Hg with an applied potential and dilute H_2SO_4 against the log. of the concentration of H_2SO_4 consist of linear portions with sharp angles. They resemble the curves showing the variation of interfacial tension between two liquid phases with the log. of the concentration of one solute, that of the other remaining constant. The surves of electrocapillarity for constant composition against interfacial tension are also drawn. The surface concentration of the solute in the Hg-dilute H_2SO_4 system is a function of the voltage. A. J. M.

See also Abstracts 1700, 1705, 1889, 1920.

TIME.

***1741. All-electric clock.** P. Vigoureux and H. E. Stoakes. *Phys. Soc., Proc.*, **52**, *pp.* 353–357 ; *Disc.*, 357–358, *May*, 1940.—The synchronous motor usually employed for obtaining seconds' intervals from a 1 kc./s. source controlled by a h.f. crystal oscillator is replaced by three multi-vibrators whose controlled periods are 10, 100, and 1 000 times that of the source respectively. On account of the extremely sharp rise of current in the multi-vibrator circuits, the intervals provided by the seconds multi-vibrator are equal to within 10 μsec. Each multi-vibrator consists of a single triode-pentode valve, injection from one stage to the next being effected on the suppressor grid of the pentode section, a method of injection which has proved superior to anode-circuit or grid-circuit injection. A check that the multi-vibrators are in steps is obtained by using their outputs to charge a condenser through the coils of a cathode-ray oscillograph whose time base is synchronized by the 1 kc./s. input. Authors.

VISCOSITY AND FRICTION.

1742. Methane-ethane-crystal oil system. B. H. Sage and W. N. Lacey. *Indust. and Engin. Chem.*, **32**, *pp.* 587–589, *April*, 1940.—The viscosity of 21 liquid mixtures of methane, ethane, and crystal oil was determined at pressures between bubble-point pressure and 2 500 lb./in^2. at a temperature of 100°F. Information concerning the viscosity of the liquid phase of these mixtures in the two-phase region was also obtained. The results are presented in graphical and tabular form. Authors.

1743. Viscosities of arabogalactan solutions. H. S. Owens. *Am. Chem. Soc., J.*, **62**, *pp.* 930–932, *April*, 1940.—The viscosities of arabogalactan solutions having concentrations of from 1–8% have been measured at 20, 25, 40, and 60°. Arabogalactan was found to have a spherical shape when dissolved in water. The molecular weight is at least 2 208, the simplest formula being $(C_5H_8O_4.(C_6H_{10}O_5)_6)_2$. Author.

1744. Viscosity and molecular structure. H. Mark and R. Simha. *Nature*, **145**, *pp.* 571–573, *April* 13, 1940.—A review. It is shown how viscosity determinations lead to reliable results for the molecular weights of proteins, and the molecular weights, degree of solvation and deviation from spherical shape of some cellulose derivatives and polystyrenes. A. J. M.

See also Abstract

938B. Flow properties of bituminous materials. A. R. Lee, J. B. Warren and D. B. Waters.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***1745. Design of slit for chromosphere spectrograph.** M. KONDO. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 251–256, *March,* 1940.—A supplement to a previous paper [see Abstract 1463 (1940)] giving details of the slit design in a spectrograph which enables He emission to be observed in the solar chromosphere. The device enables a spectrogram to be secured from the solar image at any desired height and latitude by placing the slit tangential to the limb whilst both the spectrograph and the solar image at the slit are neither displaced nor rotated. Slow motion of the slit plate allows accurate guiding when atmospheric tremor makes the image unsteady. The design minimizes scattering of integrated sunlight into the slit. A. HU.

COMETS AND METEORS.

1746. Comets. (Progress of Astronomy Reports.) M. DAVIDSON. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 327–329, *Feb.*, 1940.—The following comets have been observed: (1) Kozik-Peltier (1939 *a*), Jan. 20; (2) Väisälä (1939 *b*), mistaken for an asteroid, but found to be cometary on March 17, 1940; (3) Jurlof-Achmarof-Hassel (1939 *d*), this had many discoverers, and was remarkable in that a tail over 9° long disappeared before the next night; (4) 1925 II on June 12; (5) Kaminsky July 24; (6) Regollet (1939 *h*) on July 29; (7) Friend (1939 *n*), July 24; (8) Pons-Winnecke (1939 *c*), rediscovered March 17; Kopff (1939 *e*), April 22; Brooks (2), rediscovered June 17; Tuttle (1939 *k*) rediscovered Aug. 12; Giacobini-Zinner (1933 III) rediscovered Oct. 15; Faye (1939 *m*) rediscovered Nov. 3. A table is given of the 1939 elements of orbits. A. S. D. M.

1747. Meteors. (Progress of Astronomy Reports.) E. ÖPIK. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 315–326, *Feb.*, 1940.—A classified summary of recent researches and deductions therefrom, both observational and theoretical, on meteoric phenomena; with over 80 references. C. A. S.

COSMOGONY.

1748. Formation of nebular clusters and cosmological time scale. F. ZWICKY. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 604–609, *Dec.*, 1939.—The author contends that the existence and characteristics of the big and regular clusters of nebulae such as the Coma cluster are inconsistent with the short time scale of 2×10^9 years demanded by the theory of the expanding universe. It is shown that, if the clusters are formed out of an original random distribution by multiple collisions, a time scale of not less than 10^{18} years would be required and that if, on the other hand, the clusters existed as such in the original stages of expansion of the universe the facts regarding velocity distributions of nebulae in the cluster and between clusters would not be as observed. It is suggested that statistical counts of nebulae should be made with a view to ascertaining whether remote clusters are on an average more condensed than near clusters as required by the expanding universe theory. In his remarks on this paper M. S. VALLARTA [*ibid.* **26,** *pp.* 116–117, *Feb.*, 1940] refers to a paper by Lemaître on the theory of formation of clusters of nebulae in an expanding universe [see Abstract 1483 (1934)] which Zwicky appears to have overlooked. Lemaître showed that in an expanding universe there may be locally collapsing regions and equilibrium regions, the latter being identifiable with nebular clusters, and as long as this theory remains disproved the existence of nebular clusters cannot be regarded as in conflict with an expanding universe. J. E. K.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

1749. Stability of isolated clusters. L. SPITZER. *Roy. Astron. Soc., M.N.* **100**, *pp.* 396–413, *March*, 1940.—The fraction of stars in a simplified ideal cluster which have velocities greater than the escape velocity is calculated, using the virial theorem and the Maxwell-Boltzmann distribution of velocities. A determination of the time of relaxation gives the rate at which stars leave the cluster through this process of "evaporation". The validity of the formulae is extended to include the case in which the density increases towards the centre of the cluster. The calculations indicate that even in 10^{11} yr. a globular cluster will not lose more than half its stars by evaporation. For the short time-scale the effect on the evolution of such clusters is therefore quite negligible. In the galactic clusters the effect may be more important because of the lower average stellar velocities. Such clusters may be divided into two classes: the loose extended configurations expanding and dissipating under galactic influences, the denser ones ejecting stars and contracting. The possible fate of the latter type is discussed. A. HU.

See also Abstracts 1712, 1757.

NEBULÆ.

See Abstracts 1748, 1757.

STARS.

1750. K term and galactic rotational constants. W. M. SMART. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 370–377, *March*, 1940.—The claim of Plaskett and Pearce [see Abstract 3599 (1934)] to have solved the mystery of the K term is examined. The value of $K = 8{\cdot}3$ derived from the stars of the so-called Southern Stream is shown to have little significance; the unjustifiableness of removing the K' values from the radial velocities of the Southern Stream stars is emphasized. The arguments of Plaskett on the various solutions are critically examined; a clue is found which leads to the discovery that all Plaskett and Pearce's solutions have been made with an erroneous equation of condition. Only two solutions of moderate accuracy survive—the "uncorrected" solutions for the most distant stars of the investigation—and in these the value of the K term is essentially normal. The final conclusion is that the claim of Plaskett and Pearce to have reduced the K term to its gravitational value, thereby solving a problem of long standing, cannot be admitted. AUTHOR.

1751. Proper motions of stars belonging to the cluster Praesepe. P. C. CHAUDHURI. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 378–386, *March*, 1940.—The proper motions of 100 stars belonging to the cluster Praesepe have been derived from plates taken with the Radcliffe telescope. It is found that the centennial group-motion is $3''{\cdot}9$ in position angle $242^\circ{\cdot}9$. AUTHOR.

1752. Opacity of extended stellar atmospheres. O. STRUVE. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 117–122, *Feb.*, 1940.—The transparency of the expanding shells of P Cygni, 17 Leporis and HD 190073 is discussed; the last mentioned is certainly transparent, that of 17 Leporis shows the underlying spectrum of the stationary layer noticeably affected by continuous absorption and emission in the shell and the spectrum of P Cygni shows the optical thickness of the external shell to be very considerable. The calculated optical thicknesses of 17 Leporis and P Cygni are 0·1 and 0·5 respectively; estimates of the absorption due to H based on its known absorption coefficient and abundance in the layer give values for the optical thicknesses about one-tenth as great as the calculated thicknesses, but this factor may well be accounted for by the continuous absorption of other elements and free electrons. The continuous absorption in the shells of P Cygni and 17 Leporis accounts for the relative weakness of emission lines previously observed in these stars and leads to a rational explanation of the observed reddening in extended atmospheres. It is concluded that the absorbing region envelops the whole of the photosphere and has not the nature of a localized prominence phenomenon. J. E. K.

1753. Continuous spectrum of G-type stars. D. Chalonge and G. Déjardin. *Comptes Rendus,* **210,** *pp.* 558–560, *April* 15, 1940.—The authors' conclusions as to the continuous spectrum of the sun [see Abstract 1465 (1940)] between 4 500 and 3 300 Å are extended to other stars of type G0. The outstanding obstacle is the lack of dispersion available for these much weaker sources of radiation. However, the widest gaps in the Fraunhofer absorption, through which the true continuum can be seen, are identifiable on the stellar plates. The continua of G0 giants and dwarfs fit black-body curves of temperatures 4 650 and 5 900°K. respectively. The attempt made in previous publications from the Jungfraujoch to fit the u.v. part of the continua of G0 stars to much higher colour temperatures has been based on measurements made at points where absorption is not in fact completely avoided with the dispersion used. The new treatment ignores the discontinuity at the Balmer limit, but this is probably completely absent in G0 dwarfs, and has little effect even in giants. A. Hu.

1754. Evolution of convective stars. J. Wasiutynski. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 362–369, *March,* 1940.—It is pointed out that the strong increase of stellar luminosity in the course of evolution, obtained by Gamow and Bethe, is difficult to avoid when the stars are supposed to follow a homologous series. Possible deviations from homology are discussed and two non-homologous stellar models are studied. The first one has a convective core and a radiative envelope, the deviations from homology being caused by radiation pressure. It yields a somewhat smaller range of variation in luminosity than the corresponding homologous model, and practically no variation in radius. The other model is purely convective with negligible radiation pressure, composed mainly of H_2 and He. Its luminosity increases strongly in consequence of He synthesis from H_2, while the radius varies but little. However, these results cannot be regarded as a decisive argument in favour of Gamow's conclusion. In the real stars factors may come into play which modify the trend of evolution obtained. The sub-giant stars, indeed, differ comparatively little in luminosity but very much in radius from the main series stars of the same mass. Author.

1755. Galactic and extragalactic studies. Part VI. Summary of photometric survey of 35 500 galaxies in high southern latitudes. H. Shapley. *Nat. Acad. Sci., Proc.,* **26,** *pp.* 166–176, *March,* 1940.—By systematic photometry of many external galaxies, their space-density in a

space volume of radius, 100 million light-years may be found. High-latitude areas are free of inequalities in space absorption; the probable dimming of light by interstellar or intergalactic absorption does not exceed $0\cdot 25^m$. The *average* space density parameter in this section is $\overline{m} = 15\cdot 16 \pm 0\cdot 02$ (*m.e.*). There is evidence of a strong metagalactic density gradient across the S. galactic cap; but in the line of sight (for 13 518 objects) the density change scarcely exceeds the measurement error. Taking uniform space density as 0·6, there results: (1) a need to correct the photographic magnitudes for red-shift; (2) an intimation of the high accuracy of the stellar and nebular magnitude scales between the 15th and 18th magnitudes. [See Abstracts 3194 (1939) and 1048 (1940).]
A. S. D. M.

1756. Galactic structure. Part IV. Milky way in Cassiopeia. R. H. Baker. *Harvard Coll. Obs., Circ., No.* 424, [17 *pp*.], *rec. March*, 1940.—This Cassiopeia region is in galactic co-ordinates 75°–100° long., − 20° + 18° lat. Successive steps up to $15^m\cdot 0$ indicate that there is no conspicuous obscuration down to low south latitudes. This is checked by stellar colour excess and galaxy frequency; there may be, however, about $0^m\cdot 5$ obscuration. Analysis indicates a decrease in stellar space density with increasing solar distance, and it is hard to reconcile this with the observed star colour, if the density is uniform. Reliable obscuration amounts are given for solar distances up to 100 parsecs, except the most obscured areas. The results are confirmed by early-type stars' colour excesses, and by the galaxies distribution, and suggest that at 1 000 parsecs, the maximum total absorption may exceed the author's minimum value by $0^m\cdot 5$. Oort's analysis, however, differs from this. [See Abstracts 4398 (1938) and 3194 (1939).]
A. S. D. M.

1757. Structure and dynamics of galactic system and of elliptical nebulae NGC 3115 and 4494. J. H. Oort. *Astrophys. J.*, **91,** *pp.* 273–306, *April*, 1940.—The observed fact that the major axis of the velocity ellipsoid for bright stars in the galaxy deviates in longitude by 15°–20° from the direction of the galactic centre is provisionally interpreted as due to an unevenness in density-distribution in the galaxy. The photometry of NGC 4494 is then discussed. The light intensity is found to obey the rule $I = I_0/(1 + r/a)^2$ with $I_0 = 3\cdot 41$ and $a = 3''\cdot 0$. Similar measures for NGC 3115 are $I_0 = 3\cdot 35$, $a = 10''\cdot 2$ for the major, and $I_0 = 3\cdot 55$, $a = 2''\cdot 84$ for the minor axis of this nebula which is elliptical and is probably seen edge on. Isophotes of NGC 3115 are remarkable for the sharpness with which they run into the major axis and the straight portions which lead down to these sharp edges. Considering these observations with those of Hubble on the rotational velocity of the nebula, it seems probable that the density beyond $10''$ from the centre is 10^{-20} gm./cm^3. and is constant. The total mass is at least 5×10^{10} ⊙. The ratio of mass to light in the outer parts of the nebula is 250 whilst it is 1·8 near the sun for our galaxy. The peculiar velocities of the material producing the light must be high, about 100–200 km./sec. for the parts within $a = 20''$.
G. C. McV.

1758. Photographic survey of galactic clusters. Part I. Method and application to M103. G. Alter. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 387–395, *March,* 1940.—The paper describes a method of using the Mond quadruple astrograph of the Norman Lockyer Observatory, Sidmouth, for work on open clusters. The examination of a cluster covers: number of cluster stars, diameter of cluster, magnitudes and colour indices of cluster stars, distance of cluster, and detection of short-period variables. The four photographic telescopes of the instrument are used simultaneously for different purposes. Camera A serves for counting cluster stars and determining the cluster diameter. Camera B is used for determination of photovisual magnitudes on hypersensitive panchromatic plates without a colour filter. Camera C gives the photographic magnitudes, and camera D completes the magnitude series for the brighter stars with shorter exposure times. The reduction of cluster star magnitudes takes into account the influence of fogging effects. The colour indices are used for the recognition of cluster members and the determination of the distance and type of the cluster and the number of stars it comprises. A specimen investigation of M103 gives the following results: Pleiades type, number of stars 44, angular diameter 6′·8, distance 2 040 ± 180 parsecs, linear diameter 4·5 parsecs. A. Hu.

1759. Double stars. (Progress of Astronomy Reports.) W. H. van den Bos. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 332–333, *Feb.*, 1940.—New pairs. Distant physical companion τ Cygni (Burns); to ADS 9352 (van de Kamp); to proper motion star Lalande 21258 (van Maanen); double star with large proper motion (Luyten); Quintuple star astrographic plates (Bemporad), and an invisible companion to Mizar B (Oriano). Measures are given by Baize (Paris, 12-inch refractor); Lacchini (10-inch); Woolley (Cambridge, 12- and 8-inch); Tibor, Stein, and others (16-inch) and Schembor (8-inch); Stearns (photographic measures). Muller gives a list of provisional distances for 15 pairs; orbits are given for 13 pairs, and there are miscellaneous notes, on matters pertaining to orbit methods, etc. A. S. D. M.

1760. Variations in intensity of bright H lines in spectrum of γ Cassiopeia. Tcheng Mao-Lin. *Comptes Rendus*, **210**, *pp.* 561–563, *April* 15, 1940.—The observations consisted of 55 photographs taken at Lyons between 1936 Aug. 14 and 1939 Aug. 16. The intensity of H_β, H_γ, H_δ, H_ϵ and H_ζ relative to the continuous background was measured and it was found that the variations of these intensities varied inversely with the brightness of the star. This cannot be entirely due to the variations of the continuous background. The intensities relative to the background of H_β and H_γ were greater in 1939 than they were in 1936 but for H_δ and H_ϵ they were much weaker. G. C. McV.

1761. Distribution of stars in Taurus-Auriga region. M. Tibor. *Pont. Acad. Sci., Comm.*, **4, 2**, *pp.* 21–81, 1940. *In English.*—The author states the programme in respect of the faint stars of the Milky Way. 15 fields were selected, and this paper deals with the space and surface distribution of the Taurus-Auriga field, whose centre is at B.D. 29°·100 5; A.R.; $5^h.42^m.35^s.21$; Decl: + 29°.06′.06″3, (1 900·0) l: 147°9, b + 2°·2. 1 780 stars were classified by their spectra and both photographic and photovisual magnitudes were determined by the I.N. Polar Sequence. The spectra of bright stars were classified and for the faint ones, the colour index was used as an auxiliary classification. A plate with an exposure of 20^m for the faint stars, and another of 2^m for the bright ones served to get the photographic magnitudes of brighter stars (and therefore of all) without recurrence to other catalogues. Two figures and two tables are given as well as a catalogue of 1 780 stars in this Taurus-Auriga field, classified according to spectral types. A. S. D. M.

See also Abstracts 1722, 1749.

SUN.

1762. Unusual solar activity. M. Salaruddin and B. G. Narayan. *Indian Journ. Phys.*, **13**, *pp*. 451–454, *Dec.*, 1939.—The paper describes briefly the outstanding features of a recent persistent solar activity observed in Kodaikanal. Attempts have been made to correlate the bright chromospheric eruptions with the terrestrial effects. It is suggested that until many more data are obtained, judgment must be withheld regarding the nature of the relation between the eruptions and terrestrial magnetic disturbances. Authors.

1763. Solar activity. (Progress of Astronomy Reports.) H. W. Newton and A. L. Narayan. *Roy. Astron. Soc., M.N.*, **100**, *pp*. 330–332, *Feb.*, 1940.—Newton gives tables of relative activity for 1936–39, and dates of central meridian passage of 10 groups of spots exceeding 1 000 millionths in area. Three magnetic storms (two of them great) were associated with the first three groups. There were two intense chromospheric eruptions on Sept. 1 and 10, all in 1939. Narayan reports decline in prominence activity; 59 metallic prominences; 963 bright reversals of Hα on the sun's disc near sunspots; 282 prominence displacements. Eruptive prominences on limb were on Feb. 6, May 2 and 31, Sept. 1 and Dec. 16. Breaking up of Hα markings were on Aug. 26 and Sept. 2 and 12, the last remarkable for suddenness of disappearance. Mean daily areas of prominences (as H absorption markings on the disc) were 9 735 millionths of the visible disc against 10 161 in 1938. A. S. D. M.

See also Abstracts 1745, 1777, 1785, 1953.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

1764. Science and the divining rod. C. Maby. *Roy. Soc. Arts, J.*, **88**, *pp*. 520–535; *Disc.*, 535–539, *April* 19, 1940.—The reactions of a dowser are considered to be due to supernormal sensitivity in the nerve muscles and other organs and he is particularly responsive to corpuscular emanations such as β-and kathode (electronic) rays. H.f. oscillatory effects are induced in the dowser's muscles by local Hertzian-type electromagnetic fields, and are shown by pendulum or bent-twig movements. The dowsing electric fields exhibit parallel reaction bands and transverse standing waves, while the radiation is elliptically or plane-polarized in two directions at right angles. An almost perfect correlation exists between dowsing, ionization, Hertzian, magnetic and earth current phenomena of objects such as underground streams, pipe lines, and electric cables. The depth, flow and yield of the field can also be determined within limits. In the *Discussion* its bearing on geophysical prospecting for minerals and oil was mentioned and possible lines of training dowsers for this work. R. S. R.

See also Abstract

981B. Electrical equipment used in reflection seismograph prospecting. C. C. Nash, Jr., and C. C. Palmer.

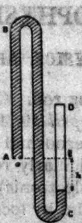
HYDROSPHERE, PHYSICS OF THE.

1765. Drift of the ice-breaker "Sedov". N. N. Zubov. *Nature*, **145,** *pp.* 533–539, *April* 6, 1940.—The drift began on Nov. 1, 1937, starting west of the New Siberian Ids., and was generally (though with many minor deviations) N.E. to 153° 26′ E., 78° 25′ N. in Jan. 1938, then N.W. to 86° 34′, 108° 50′ E., on March 22, 1939. It then turned W and increasingly S.W. with increasing speed, reaching 81° 15′ N., 4° 16′ E. on Jan. 1, 1940. The chief results include proof of the non-existence of Sannikof land (north of Kotelmy Id.), and of a deep basin in the Arctic Ocean from about 78° 30′ N. (max. depth found over 5 180 m. in 86° 36′ N., 39° 25′ E.). The drift showed a substantially smaller amount of ice and less cold than was found by the " Fram " in 1894–7—min. temp. − 44·1° on March 10, 1939 in 86° 23′ N., 110°20′ E., as against − 52° in 84° 55′ N., 41° E. on Jan. 15, 1896 found by the " Fram". To Nansen's laws—(1) that the speed of wind drift is approximately 1/50th that of the wind causing it, and (2) its direction is, due to the earth's rotation, 30–40° to the right of that of the wind, which are confirmed, are added (3) the drift of the ice follows the isobars, so that the region of high pressure is to the right, of low to the left, and (4) the speed of the drift is proportional to the gradient of atmospheric pressure. The directions of warm and cold currents are discussed. C. A. S.

1766. Monthly and annual mean heights of sea-level up to and including the year 1936. *Union Géodésique et Géophysique Internationale, Assoc. d'Océanographie Physique, Publ. Scientifique No.* 5, [255 *pp.*], 1940.

LAND, PHYSICS OF THE.

***1767. Porosity of soils and rocks.** F. Diénert. *Comptes Rendus*, **210,** *pp.* 444–446, *March* 18, 1940.—The portion ABE of the tube figured is filled with water. If closed at A with a plate containing a very small hole (*o*), and placed so that the water can evaporate, the level at E falls gradually through a distance *h*, depending on *o* and is equal to the elevation of water by capillarity in a tube of that diameter. Similarly if the closure at A is effected by a sample of soil or rock, *h* depending on the size of the interstices, will vary inversely as the dimensions of the constituent particles so measuring the porosity of the soil or rock. C. A. S.



1768. Underground water circulation in fissured ground. F. Diénert. *Comptes Rendus*, **210,** *pp.* 483–485, *March* 27, 1940.—Quantities a_0, b_0, per litre of two substances of different coefficients of diffusion, K, K′ (e.g. NaCl and glycocoll) are dissolved in the water of the well with agitation, and the amounts per litre (a_t, b_t) after time *t* determined. From the rate $(a_0 - a_t)/(b_0 - b_t)$ of the losses of the two substances—due to diffusion and draining away through fissures in the walls of the well and its replacement by fresh water—the circulation of water in the well is determined. The method of calculation is given, and inferences drawn from the various possible results. C. A. S.

See also Abstracts 1713, 1764.

METEOROLOGY.

1769. Return period of extreme annual temperatures. E. J. Gumbel. *Comptes Rendus*, **210,** *pp.* 468–470, *March* 27, 1940.—The probability that an event have a value lower than some stationary value x of a variable being given, the periods of return of a value greater than or lower than this stationary value are defined in terms of this probability. This is then extended in such a way as to show that, if y is a linear function of x, then the logarithm of the return period of the largest value greater than y equals that of the smallest value less than $-y$ and that both tend to y. With the daily temperature as the variable x, then it results that the number of years, giving an annual minimum temperature less than $-y$, ought to be equal to the number showing an annual maximum temperature greater than y, and so the period of return should be equal in the two cases. A method of checking this is indicated. Comparisons between observed results, and theoretical values afford criteria for examining extreme values. A. E. M. G.

1770. Solar u.v. spectral energy curve. E. Pettit. *Mt. Wilson Observat., Contrib. No.* 624. *Astrophys. J.*, **91,** *pp.* 159–185, *March,* 1940.—The observation programme was the same as at Tucson [see Abstract 3599 (1932)], the constant dispersion being used throughout. A plot shows that the years 1931, 1934, 1937 and 1939 give the same general features; a sudden drop of 48% in solar energy between 0·40 and 0·38μ, and a nearly constant one between 0·38 and 0·325μ. The integrated light curve ordinates are nearly everywhere proportional to those at the disc's centre, and particularly so in the u.v., where both curves show the rise in intensity between 0·38 and 0·35μ. Below 0·32μ, the integrated light curve runs even a little higher than that for the disc's centre, which is hard to understand. The limb darkening seems not to vary greatly throughout the u.v. region. The low value of atmospheric ozone above Mt. Wilson is confirmed. The u.v. energy between lines is discussed. It is significant that H and K play little part in the great drop of intensity between 9·40 and 9·38μ. A. S. D. M.

1771. Fluctuations in the solar constant. H. R. Hulme. *Observatory,* **63,** *pp.* 101–105, *April,* 1940.—The author considers the problem of the reality of Abbot's periodicities in the values of the solar constant. The probability that the amplitudes found by Abbot are small enough to have arisen from statistical fluctuations is evaluated, period by period, without making the assumption that the 10-day means used by Abbot are independent, i.e. that the causes producing the variations are not operative over many sets of 10 days. Random fluctuations active for a time comparable with a quarter of a period are found to be quite capable of producing periodic terms which have the amplitudes found but are nevertheless without physical reality. It is emphasized that misleading results can be obtained by calculating from the observations the probable errors of the amplitudes: the observations are not in fact independent. Random effects can be imagined in the instruments, the atmosphere, or the solar constant which last for a number of 10-day intervals; and it is shown that such effects can cause the observed "periodicities". A. Hu.

1772. Pressure wave and boundary surfaces in free atmosphere. D. S. Subrahmanyam. *Indian Journ. Phys.*, **13**, *pp.* 419–437, *Dec.*, 1939.—After referring to the observed discontinuities in the atmosphere the author states that the present paper attempts to connect these discontinuities with the pressure oscillations that take place in the atmosphere. On the assumption that an element of air remains constant for small displacements, and that the atmosphere is divided into layers between which no mixing takes place a theory of canal waves for air is developed. Among the results obtained are: (1) the boundary surface corresponding to the semi-diurnal pressure vibration resembles the tropopause; (2) mixing can take place between the ground and this surface but not beyond it; (3) the possibility of a number of strata above the tropopause; (4) an isobaric boundary surface at 21·85 km.; (5) the possibility of other higher boundary surfaces at heights corresponding closely to the E, F and D ionized layers. While it is not claimed that the theory presented is complete still it may be regarded as a new approach to the understanding of some phenomena not yet fully understood. A. E. M. G.

1773. Condensation nuclei. E. Salles. *Rev. sci., Paris*, **78**, *pp.* 77–84, *Feb.*, 1940.—Reference is first made to the discovery of these nuclei, their numerical distribution over land and sea at different seasons, and to the methods of observing their distribution. From diffusion observations it has been possible to find their mass. In dealing with their origin the author considers the effects of salt spray, traces of acids and ammonia in the air, and the presence of very finely divided silica and carbon. Turning to effects of the products of combustion, those from motor cars appear to be very effective in producing fogs, condensation taking place with relative humidities in the neighbourhood of 70%. Measurements of nuclei content during rain, while in some cases showing a marked diminution, in others indicate little or no change. The connection between the formation and disappearance of fogs in different localities and the nuclei content is fully considered; also diurnal and annual variation of this content. Consideration is then given to dust particles and to the method of measuring their content by Owens' apparatus. The whole summary, however, shows that many points require to be cleared up. Some of these the author mentions. Further he considers that the exact examination of these nuclei is likely to prove very helpful in a study of atmospheric pollution. A. E. M. G.

1774. Absorption of yellow twilight ray by sodium vapour. A. Kastler. *Comptes Rendus*, **210**, *pp.* 530–532, *April* 8, 1940.—Two quartz cells, one full of Na vapour and the other, a control cell, full of air, are pointed northwards at 23° to the horizon and the twilight yellow ray [see Abstract 4431 (1938)] passes through each. Spectra of the two cells are photographed on the same plate. The cells are heated by a current of hot gas and the temperatures at both ends of the cell containing Na vapour are measured. It is shown qualitatively that the *D* twilight ray, which is very intense with the control cell, is weakened and finally disappears as the temperature of the Na cell is raised. The coefficients of absorption have been calculated for different experimental conditions. The components of the yellow twilight ray have a width of approximately 0·03 Å of the order of the Doppler effect for the temperature range 100–300°C. W. R. A.

1775. Variations within auroral spectrum. L. Vegard. *Terr. Mag.*, **45**, *pp.* 5–12, *March*, 1940.—Discusses two spectrograms obtained from quiet auroral arcs which indicate the presence of H_2 in the upper atmosphere, attributed to showers of H_2 or to a kind of " H radiation " occasionally coming from the sun. Variations of intensity with latitude are also discussed, as are altitude effects. A. H.

1776. Excitation functions of nitrogen bands and their bearing on auroral problems. B. Rypdal and L. Vegard. *Geofysiske Publ.*, **12,** 12, *pp.* 3–20, 1940. *In English.*—An experimental arrangement is described for measuring the true excitation functions free from secondary effects due to collisions of the second kind or multiple electron collisions. The method used is to accelerate the electrons which then enter a luminescence chamber where the electric field is zero. The effective potentials are found by measuring the ignition potential for He used as a standard gas. The ignition potential of the 1st positive group of N_2 [(0–0) band] was found to be 9·4 V, for the 2nd positive group [$(0-\nu'')$], series, it was 13·4 and for the negative group [(0–0) band], 16·4 V. Applying these results to the average auroral spectrum, the energy of the electrons producing the spectrum is deduced to be 29 V. This must, however, be regarded as the average energy only of the aurora-producing stream of electrons. The average velocity of the exciting cathode rays increases on passing from the bottom edge to the upper limit of an auroral streamer. G. C. McV.

1777. Aurorae and sunspots. H. H. Clayton. *Terr. Mag.*, **45,** *pp.* 13–17, *March*, 1940.—From data for the period 1885–1939 as recorded at Blue Hill (Massachusetts) omitting faint aurorae, results show maximum numbers thereof in March and Sept., minimum in June and Nov.; a maximum one year after a sunspot maximum; a maximum of spots in the central area of the sun one day before the occurrence of an aurora; (somewhat doubtfully) that the greatest area of spots in the central zone of the sun precedes the aurora by 1–4 days; that more brilliant aurorae are preceded by larger spots; that for the production of aurorae, the further from the centre of the disc the spot is the larger it must be; and that the aurora occurs about 1½ days after the spot has crossed the central meridian. C. A. S.

***1778. Night-visibility determination with Wigand's or Bennett's visibility meter.** A. K. Roy. *India Meteorolog. Dept., Sci. Notes,* **8,** 86, *pp.* 23–30, 1940.—The paper gives a simple method of determining the visibility code figure at night with the help of a Wigand's or Bennett's visibility meter and two landmark lamps of low candle power at short distances from the observatory. By calibrating the visibility meter, according to the method described in the paper, it is seen that the curve obtained by plotting n against log I is approximately a straight line, showing that the obscuring power of filter marked n is equal to that of n filters marked 1. With the help of the calibration curve a table has been drawn up which gives the meter readings corresponding to the different grades of filters that would be required to reduce the intensity of illumination from the two landmark lights to the limiting value for vision, under different conditions of visibility. The observation of visibility consists simply in viewing the two lights by turn through the visibility meter and in noting the meter readings at which the lights are just made invisible. From the meter readings thus obtained one finds the visibility at the time of observation by reference to the table mentioned above. Author.

***1779. Visibility meter.** G. D. Shallenberger and E. M. Little. *J.O.S.A.*, **30,** *pp.* 168–176, *April*, 1940.—Measurement of air visibility is necessary in the detection of forest fires. The instrument developed for this purpose is an optical one consisting of an attachment to one lens of a prismatic binocular. This is a small-angle prism of 0·5 dioptre which is moved past a small aperture before the objective. When covering part of the aperture there are two images in the field of view, the added one being due to the presence of the prism. Adjustment is made until the boundary line just disappears and the prism position and object distance then noted. Clarity is arbitrarily determined from these figures. The mathematical theory is given. E. H. W. B.

See also Abstracts 1782, 1953.

SEISMOLOGY.

1780. Derivations of travel-time curves. C. H. DIX. *Seismological Soc. of America, Bull.*, **30,** *pp.* 25–26, *Jan.*, 1940.—The behaviour of the second derivative, $d^2t/d\Delta^2$, when the source is at the surface $r = r_0\theta$, where θ is the angular distance to where the time t is measured, has been considered. It is assumed that the velocity of propagation $V(r)$ is a function of r only. The following proposition is derived:—If $V(r)$ is a function of r only such that $K(r)$ exists at r_0 and the focus is at r_0, then if $K(r_0) \geqq 0$ then $d^2t/d\,\Delta^2 = 0$ at $\Delta = 0$, and if $K(r_0) < 0$ and $K(r)$ exists and is finite and continuous in a neighbourhood $(r_0, r_0 - \delta r)$ then $d^2t/d\Delta^2 = 0$ at $\Delta = 0$. R. S. R.

1781. New method of calculating epicentral depth. P. CALOI. *Ricerca Scientifica*, **11,** *pp.* 45–48, *Jan.–Feb.*, 1940.—Further notes are given on the graphical method previously described [see Abstract 4527 (1939)]. W. A. R.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

1782. Atmospheric ionization at Mangalia. M. HEROVANU. *Soc. Roumaine de Physique, Bull.*, **40,** 74, *pp.* 57–76, 1939.—The author has determined the number of small ions in the atmosphere of Mangalia on the Black Sea, during the months of July and Aug., 1939. The analysis of observation data shows the influence of the radioactive sources of the region and brings to light a peculiarity not yet observed elsewhere, namely the increasing of the quotient of positive and negative ions with the vapour tension of water in the atmosphere. The author studies also the relation between the number of ions and the terrestrial electric field, the intensity of u.v. radiation and the opacity of the atmosphere. AUTHOR.

1783. Local variation of potential-gradient at Taihoku, Formosa. K. OGASAHARA. *Terr. Mag.*, **45,** *pp.* 53–69, *March*, 1940.—The observations were carried out in lat. 25° N., long. 121° 32″ E. from June 1934 to July 1936. The method of observations is described, and the difficulty in obtaining good insulation stressed. Tables give the mean monthly, annual, and seasonal average potential-gradient for each hour of the day. The results appear to indicate that there exists a very marked single diurnal variation in potential-gradient as opposed to the double variation found in temperate climates. This variation exhibits various types, a summer type June–August, a winter type Oct.–March, and an intermediate type April and Sept. In discussing the results the author tries to find an explanation of the peculiar behaviour in the atmospheric-electric and meteorological conditions in the neighbourhood of the station. O. W. TORRESEN, *ibid.*, *p.* 70, commenting on the figures is of the opinion that part of the cause may be due to variation in insulation and that until any such possible source of error has been removed, it is impossible to draw definite conclusions from the observations. A. E. M. G.

1784. Six-month period of terrestrial magnetic activity and its relation to F_2-layer of ionosphere. H. NAGAOKA. *Imp. Acad. Tokyo, Proc.*, **16**, *pp.* 26–32, *Feb.*, 1940.—When solar activity increases, the sun is presumed to be charged positively, and negative charges are induced on the surface of the planets. The earth is surrounded on the outside by the F_2-layer, the free electrons of which, if disturbed or altered in number, produce magnetic disturbances. Observation of the F_2-layer indicates that it is disturbed during magnetic storms. A sketch of the electrical theory is given, and from it the positions found for the maxima of magnetic disturbance are March $31{\cdot}8^d$ and Oct. $8{\cdot}1^d$; those found by Bartels for 1872–1930 were April 5 and Oct. 4. With excess of electrons in space, the maxima appear earlier than the calculated date, and when solar activity is low there is retardation in reaching the maxima. G. E. A.

1785. Variation of magnetic character-numbers at Dombås Observatory. K. F. WASSERFALL. *Terr. Mag.*, **45**, *pp.* 1–4, *March*, 1940.—The character-number for Dombås is based on absolute storminess for D. This is the sum of the deflections in gammas of the 24 hourly means of the day from a normal line representing undisturbed conditions. A table shows the good agreement between the monthly mean values for 1937 of character-figures, D, at Dombås and the international character-figure, C. The two 11-year periods, 1917–27 and 1928–38 show also a good agreement for the mean monthly values but not so good in the mean annual variation from year to year. The departures are small from 1926–38 but considerably greater from 1917–25. To obtain parallelism with sunspot values the scale has to be displaced two years. R. S. R.

1786. Magnetic perturbation of March 24, 1940. L. EBLÉ, G. GIBAULT AND E. TABESSE. *Comptes Rendus*, **210**, *pp.* 542–543, *April* 8, 1940.—Details are given of the changes in declination and horizontal and vertical intensity at Chambon and Nantes during this intense magnetic storm. At Mascart the magnitudes have been exceeded only 3 times since 1883. The magnetic storm occurred simultaneously over several regions with difficulties in signalling and a most exceptional auroral display. The magnitude is rarely attained in these latitudes and it was of remarkable duration. It was followed four days later by another prolonged magnetic storm. R. S. R.

See also Abstract 1762, and

932B. Influence of a cloud on lightning experiments with models. W. Weber.

RADIOACTIVITY.

1787. New method for separation of active fission-products from U and Th. O. HAHN AND F. STRASSMANN. *Naturwiss.*, **28**, *pp.* 54–61, *Jan.* 26, 1940.—The active deposit of Xe- and Kr-isotopes originating from the fission of U was collected on a negatively charged Cd-plate. The U-compounds used were prepared as very finely powdered or loosely deposited specimens of high emanating power, with the result that even very short-lived gaseous isotopes contributed to the deposit. By chemical separation (which had to be carried out very rapidly on account of the short decay periods involved) it was established that the short-lived alkali recently discovered by Aten, Bakker and Heyn (*Nature*, **143,** *p.* 679, *April* 22, 1939) is actually composed of a Cs-isotope and a Rb-isotope of 40 sec. and 80 sec. half-life respectively. Further it was shown that 2 active Sr isotopes (of 6 hr. and 54 days half-life) which previously were believed to be produced directly by the fission of U, are really derived by series of 2 β-decays from Kr-isotopes. A scheme of the occurring chain reactions including all identified active nuclei is suggested. The same active periods were obtained when the method described was applied to a suitable Th-compound, which, however, had to be prepared from a source freed from thoron. L. E. F.

1788. Neutron-induced radioactivity in Cb (Nb). R. Sagane, S. Kojima, G. Miyamoto and M. Ikawa. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 174–182, *Feb.*, 1940.—A study has been made of the radioactivities produced in Cb (Nb) by slow and fast neutron bombardments. The results obtained are as follows :—

Cb^{93} (n, γ)	Cb^{94}	$6{\cdot}6 \pm 0{\cdot}3$ min(1).	(e^-)	—
Cb^{93} $(n, 2n)$	Cb^{92}	11 ± 1 days	(e^-)	$1{\cdot}38 \times 10^6$ eV (K – U).
Cb^{93} (n, α)	Y^{90}	66 ± 2 hours	(e^-)	$2{\cdot}11 \times 10^6$ eV, $0{\cdot}90 \times 10^6$ eV (K–U).

Chemical identification and cloud-chamber study of the β-rays have been made in Cb^{92} and Y^{90}, produced by processes mentioned above. Arguments are given for the assignment to these isotopes. Authors.

1789. Energy of photo-neutrons liberated from deuterons by RaC γ-rays. K. Kimura. *Kyoto Coll. Sci., Mem.*, **22,** 4, *pp.* 237–248, 1940.—The author studied in detail the photo-neutrons liberated from D and Be by Ra C γ-rays, and especially determined, for D, the thickness of paraffin wax which was necessary to slow them down to the energy of the resonance absorption of I. From this it was ascertained that 2·198 eMV γ-rays really act in the disintegration of D, and the initial energy of liberated neutrons was estimated to be between 0·001 and 0·007 6 eMV, and hence the binding energy of the deuteron was $2{\cdot}189 \pm 0{\cdot}007$ eMV, which gave the mass of the neutron 1·008 95. The relative atomic cross-section for photo-disintegration of D against Be was $\sigma_D : \sigma_{Be} = 1 : 13$. Author.

1790. Groups of protons emitted on bombardment of H-like substances with Po α-rays. Parts I and II. Tsien San-Tsiang. *J. de Physique et le Radium*, **1,** *pp.* 1–11, *Jan., and pp.* 101–111, *March*, 1940.—The protons emitted from H-like substances on bombardment with Po α-rays have been investigated with a special Wilson chamber having a long effective time. The numerical distribution of protons of different ranges, projected forwards and at angles up to 50°, shows that six different groups exist. As the energy of the incident α-rays is decreased, in each case the group of protons with the highest energy disappears first at all angles. This permits of the conclusion that the groups of protons emitted on collision with α-particles correspond to excitation levels of the nucleus ^5_3Li. The six groups found correspond to the following values of the ranges of the α-rays :—1·57, 1·87, 2·26, 2·65, 3·03 and 3·53 cm. The spacing of the levels of ^5_3Li in this region is small and sensibly constant, having a value of approximately 90 ekV. In the diffusion of α-particles by the H nucleus, the ratio of the effective cross-section, as observed experimentally and as calculated from Rutherford's formula, shows a variation periodic with the energy of the α-particles. The results on the groups of protons have been compared with those of other workers. A large interaction distance is obtained between $^{4}_{2}He$ and $^{1}_{1}H$, which is also discussed. According to the experimental data, $^{5}_{2}He$ would exist in a stable state, while $^{5}_{3}Li$ would be unstable. The results have been discussed from the points of view of the theories of Mott, Beck and Bethe, and a possible explanation of the groups has been suggested. G. O. B.

1791. Excited states of O^{16} nucleus. D. M. Dennison. *Phys. Rev.*, **57,** *pp.* 454–456, *March* 1, 1940.—The levels of O^{16}, as predicted by the α-particle model, are examined mathematically to see to what extent they may satisfy the requirements of Oppenheimer and Schwinger laid down in their discussion of the results of the bombardment of F by protons. A. H.

1792. Relative probability for loss of neutrons and α-particles from an excited nucleus. J. M. Cork and J. Halpern. *Phys. Rev.*, **57,** *pp.* 667–668, *April* 15, 1940.—A stack of foils of very pure Fe was bombarded with deuterons of energy 10 eMV. Excitation curves are thus obtained for a radioactive Mn of half-life 21 min. made by a (*D*,α) reaction and a radioactive Co of half-life 18 hr., made by a (*D*,*n*) reaction. These radioactive isotopes are both derived from the same parent Fe isotope. Hence the radioactive yields reveal the relative probability of the escape of a neutron and the escape of an α-particle from the same excited nucleus. As the energy of the incident deuterons is increased the intensity of the 18-hr. (*D*,*n*) Co attains a maximum value at about 7·5 eMV. There is a progressive increase with energy in the activity of the 21-min. (*D*,α) radioactive Mn. At 10 eMV the escape of a neutron is about 3 times as probable as the escape of an α-particle. Authors.

***1793. Circuit for anticoincidences with Geiger-Müller counters.** G. Herzog. *Rev. Sci. Instruments*, **11,** *pp.* 84–85, *March*, 1940.—In certain cloud-chamber experiments, the release of the chamber is to be avoided by counter control should coincidences occur. The basis of the method is to give an impulse from anticounters opposite in sign to that given by the counters. The sign difference may be accomplished by introducing a time lag in the arrival of the pulses from different counters thus making the existence of pulses non-evident. Various other methods of neutralization especially suited to particular circuits are described. The efficiency of the process is nearly 99%. F. C. C.

See also Abstracts 1799, 1924, 1950, 1951.

RADIATION.

ABSORPTION.

See Abstract 1823.

COLORIMETRY.

1794. Luminous efficiency of 2-element complementary colours: white luminescence from Braun tubes. T. Azuma. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 162–173, *Feb.*, 1940.—The luminous efficiencies of 2-element complementary colours are calculated according to I.C.I. colorimetry. As an application of the theory, the white luminescence from Braun tubes used in television is discussed. A convenient method of photographic spectro-photometry of continuous spectra is explained. AUTHOR.

1795. U.S.A. colour standards for rosin. B. A. BRICE. *J.O.S.A.*, **30**, *pp*. 152–158, *April*, 1940.—The new official U.S.A. colour standards for grading gum rosin are described and compared with the superseded 1923 Lovibond glass standards. The new standards are made of cemented combinations of Jena and Corning glasses, and show a better spectral match with rosin, higher luminous transmission, more regular spacing of colours on a chromaticity scale, and are more solidly constructed than the old standards. Spectral transmission curves for rosins and the glass standards are shown. The standard colours are specified in terms of the 1931 I.C.I. colorimetric coordinate system with its standard observer and standard illuminant C. Chromaticity tolerances are established for duplicate standards. AUTHOR.

1796. Use of uniform chromaticity scales. J. G. HOLMES. *Phys. Soc., Proc.*, **52**, *pp*. 359–370, *May*, 1940.—The C.I.E. trichromatic system is capable of modification to a similar system of three coordinates in which a diagram of colours has the property that the distance between the points representing two colours is approximately proportional to the subjective colour-difference. It is shown that a similar effect can be obtained by a distortion of the C.I.E. coordinate lattice giving either the uniform chromaticity system proposed by Judd [see Abstract 668 (1935)] or the rectangular uniform chromaticity system proposed by Breckenridge and Schaub [see Abstract 4291 [1939)]. Nomographic transformations between the systems are also described. The object of these transformations is to enable results which are recorded on the C.I.E. basis to be plotted or visualized on the U.C.S. system. AUTHOR.

1797. Colour of pigment mixtures. D. R. DUNCAN. *Phys. Soc., Proc.*, **52**, *pp*. 390–400; *Disc.*, 400–401, *May*, 1940.—It is shown that the colours produced by mixing pigments in any given medium may be deduced from formulae involving two constants for each pigment. These constants, which vary with the wavelength of the incident light, measure respectively the absorbing power of the pigment for light and its scattering power. Relative values of these constants for a series of pigments may be deduced from their reflectivities at different wavelengths and the reflectivities of one mixture of each pigment with one standard pigment. The relative values so obtained enable the reflection curves, and hence, if desired, the colours, of any mixture of two or more of the pigments investigated to be predicted correctly. AUTHOR.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

1798. Optical and magneto-optical study of mixtures. J. RABINOVITCH. *Ann. de Physique*, **13**, *pp*. 176–238, *March–April*, 1940.—Several organic mixtures have been examined from the viewpoint of the natural rotatory power, the Faraday effect, and the Cotton-Mouton effect. Measurements of the natural rotations of a β-pinene-benzene solution show that the deviations from the Biot additivity law are due to molecular association. Further, measurements of the magnetic rotations and the magnetic birefringences deviate from the hypothesis of a polymerization of β-pinene molecules and a dimorphism of these molecules. The data can be explained however on the basis of the formation of benzene-β-pinene addition compounds. The investigation of the magnetic rotatory power and birefringence gave results which clarify certain anomalies encountered in

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mixtures of natural inactive substances. Thus, the direction and magnitude of deviations for a solution of β-methylnaphthalene in CCl_4 are attributed to a partial transformation of the β- to the α-isomeride.

W. R. A.

EMISSION.

1799. Second maximum in Rossi curve. B. Ferretti. *N. Cimento,* **17,** *pp.* 13–25, *Jan.*, 1940.—This paper contains a theoretical discussion of mesotron and γ-ray showers produced by the interaction of mesotrons and secondary electrons, particularly in the case of γ-rays of relatively low energies and high penetration compared with very soft cosmic rays. The transition phenomena resulting from such showers are discussed semi-quantitatively. It is concluded that the showers of mesotrons and of direct and indirect secondaries formed by Coulomb collisions have a penetration greater than that usually attributed to them. Their number is a maximum when the secondary radiation in which they are generated has a relatively high penetrating power (> 10–12 cm. Pb), and an attempt is made to interpret the second maximum of the Rossi curve on the hypothesis that it is due to these showers. E. E. W.

1800. Photographic registration of ultra-radiation emitted from the stratosphere. T. Takeuti and S. Huzisawa. *Phys. Math. Soc. Japan, Proc.,* **22,** *pp.* 145–146, *Feb.*, 1940. *In German.*—A brief reference is made to the photographic registration, by means of photographic plates covered with paraffin, of orbits and disintegration processes of ultra-radiation emitted from the stratosphere. J. S. G. T.

1801. Interpretation of neutron measurements in cosmic radiation. H. A. Bethe, S. A. Korff and G. Placzec. *Phys. Rev.,* **57,** *pp.* 573–587, *April* 1, 1940.—The various factors influencing the energy distribution of neutrons in the atmosphere are investigated, and it is found that diffusion equilibrium exists except for about 1 m. of water at the top and 1 m. above ground. An equation is given for the energy distribution below 100 ekV, which contains few thermal neutrons. As an example of ground influence, the neutron distribution is calculated in the air above a water surface. The various experimental arrangements are discussed. A detector such as a BF_3 counter measures essentially the density of neutrons, and the evaluation of experiments using hydrogenic material to slow down the neutrons is considered. From these two types of experiments concordant results for neutron production are obtained. N. M. B.

1802. Average number of electrons accompanying a cosmic-ray meson. E. J. Williams. *Cambridge Phil. Soc., Proc.,* **36,** *pp.* 183–192, *April,* 1940. —The number of electrons per meson is put equal to the ratio of electron track to meson track, i.e. equal to the ratio R of specific energy-loss Q of meson to energy-loss S of electron per cm. total track. Q is calculated by assuming Coulomb interaction between meson and electron. S is estimated by assuming constant utilization of energy for the formation of electron track down to a limiting electron energy q_1, below which range is neglected altogether. The effect of radiation losses is more difficult to estimate, but it also depends on a limiting energy q_2 of the secondary quantum. R is thus evaluated in good approximation for various media. The approximation gets worse, however, if, in order to make calculations applicable to experimental conditions, electrons above a certain energy only are counted. Results were discussed in a previous paper [see Abstract 3638 (1939)]. L. E. F.

1803. Photophoresis, electrophotophoresis and magnetophotophoresis. F. Ehrenhaft. *Ann. de Physique*, **13**, *pp.* 151–175, *March–April*, 1940.—"Photophoresis" describes the phenomena characterized by the movement of particles with respect to a ray of light (which must generally be greater than a minimum intensity); the movement may be in the direction of the light or in the opposite direction (photopositive and photonegative longitudinal photophoresis respectively); again, it may be perpendicular to the ray of light (transverse photophoresis). Photophoresis is affected by both electrical and magnetic fields, thus giving electrophotophoretic and magnetophotophoretic (both longitudinal and transverse) phenomena. Certain astronomical phenomena which seem to indicate the existence of photonegative photophoretic effects are mentioned. Some of the phenomena can be explained solely on consideration of the pressure of radiation and of radiometric forces. Comparison of the present data with recorded data reveals that the phenomena depends linearly on the field strength (for weak fields) and on the intensity of the light, and that they have the same order of magnitude in different gases and in liquids. The existence of these phenomena suggests the operations of a hitherto unknown force constituting a reciprocal action between matter and electromagnetic radiation.

W. R. A.

See also Abstracts 1828, 1871.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

***1804. Fluorescence analysis. Parts I and II.** H. Gotô. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 458–479, *March*, 1940.—In Part I an apparatus for fluorometry by the use of filtered u.v. rays was constructed, and therewith fluorescein and eosine were determined. The relations between the intensity of the fluoroscence and the *p*H of the solutions are given in graphs, indicating the condition of change in fluorescence, and also the range of the *p*H, within which the fluorometric estimation is feasible. In Part II the relations between the *p*H of solutions and the intensity of fluorescence of ten typical fluorescence indicators for acidimetric titration are studied; the problem concerning the *p*H of the fluorescence change is cleared up and the characteristics as well as the suitability of each indicator are shown.

Author.

1805. Preparation of fluorescent calcite. G. R. Fonda. *J. Phys. Chem.*, **44**, *pp.* 435–439, *April*, 1940.—A calcite in which fluorescence can be excited by exposure to u.v. light was prepared by precipitation from a mixture of $CaCl_2$ and $MnCl_2$ with $(NH_4)_2CO_3$ at 70°, with suitable after-treatment. There is an optimum concentration of Mn for greatest fluorescence. A true fluorescent calcite cannot be prepared by thermal treatment, though a fluorescent CaO containing $CaCO_3$ and 0·005% Mn as oxide can be obtained by firing CaO or $CaCO_3$ with MnO at 1 000° in an atmosphere of CO_2. The lattice constants of natural and precipitated fluorescent calcite and aragonite have been determined. A. J. M.

1806. Spectrophotometry of electrophotoluminescence. G. Destriau and P. Loudette. *J. de Physique et le Radium*, **1**, *pp.* 51–55, *Feb.*, 1940.—The authors have already noted that the luminescence excited in certain solids by electric fields alone gives spectra which are shifted relative to the bands given by other means of excitation [see Abstract 2052 (1939)]. The effect is here investigated in further detail for ZnS·Cu, ZnS·Mn and ZnS·CdS. In the first case the band is shifted towards the long-wave side but in the other cases towards the short-wave side. The latter is considered to be the more common case. J. E.

1807. Photoluminescence of scheelites. M. Servigne. *Comptes Rendus,* **210,** *pp.* 440–442, *March* 18, 1940.—Examination of the photoluminescence of 15 scheelites has revealed the presence of oxides of Pr, Nd, Sm, Gd, Dy, Eu, Tb, and Er in amounts depending on the origin of the sample. The relative abundances of the elements are tabulated. [See Abstract 4061 (1939).] W. R. A.

1808. Luminescence of pure Ra and Ba compounds. D. H. Kabakjian. *Phys. Rev.,* **57,** *pp.* 700–705, *April* 15, 1940.—Luminescence, excited in some carefully purified crystalline Ba and Ra compounds by α-, β- and γ-rays has been examined. It is found that these compounds show a faint luminescence at ordinary room temperatures. When the compounds are heated to various temperatures and then cooled, they show a continuous increase in luminescence with increase of temperature of heat treatment until a maximum is reached. Heat treating at higher temperatures diminishes the brightness. The temperature of maximum brightness is not directly related to the melting point of the individual compounds. The maximum brightness in some cases was several hundred times the initial brightness of unheated crystals. No abrupt changes in intensity of luminescence, such as might be due to changes in crystalline form, were detected. The bearing of these experiments on the modern theories of luminescence in crystalline solids is discussed. Author.

See also Abstract 1834.

INTERFERENCE, DIFFRACTION AND SCATTERING.

1809. Haidinger's rings in non-uniform plates. C. V. Raman and V. S. Rajagopalan. *Phil. Mag.,* **29,** *pp.* 508–514, *May,* 1940.—By the use of an opaque screen, which diffuses light and can be brought very close to the transparent plate, and by observing the latter through an aperture of suitable size and shape in the screen, it is possible to see and photograph the Haidinger rings by reflection in plates which are neither plane nor parallel. The most efficient form of aperture is a narrow slit which is orientated parallel to the contours of equal thickness on the plate; the use of this enables a diametral section of the Haidinger pattern containing a very large number of perfectly defined interferences to be observed even with relatively thick and non-uniform plates. The use of a small circular aperture instead of a slit enables the complete rings to be observed, but in this case the limitation of aperture impairs the definition of the outer and more closely spaced rings. The transition from the Haidinger to the Newtonian variety of interferences may also be followed using the diffusing screen with a small circular aperture and gradually removing the plate under observation to a sufficient distance from it. [See also Abstract 4557 (1939.] Authors.

1810. Absorption correction in Rayleigh scattering. P. Putzeys and E. Dory. *Ann. Soc. Sci. de Bruxelles,* **60,** *pp.* 37–44, *March* 9, 1940.—Investigations of Rayleigh scattering involve measuring the ratio of the intensities of scattered and incident light. If the medium is colourless, a correction for absorption is usually negligibly small. When the medium absorbs the incident light appreciably, a correction must be applied. The authors do this by measuring the absorption of the light at the time of the experiment; this paper is concerned with the calculation of the correction. It is shown that it is important to concentrate the light into as small a space as possible when measuring the scattering. A. C. M.

See also Abstracts 1894, 1896, 1897.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

1811. Production of atomic metastable states by photo-ionization and recombination. T. YAMANOUCHI. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp*. 33–41, *Jan*., 1940.—The process studied is that of an atom in the ground state which is ionized by the photo-effect in a radiation field, whereby the atom thus produced gains one electron again by the same effect and so gives rise to metastable states. The problem is to find the transition probabilities of dipole radiation, and this is much simplified by the fact that there is no need to specify the resultant state of the ion and of the ejected or recombining electron, but only the state of the ion. A section is devoted to finding the probability that an atom (or an ion) is ionized by the absorption of light quanta in the radiation field. The formulae for p^n configurations are summarized in the concluding section.

H. H. Ho.

1812. Photo-ionization and recombination of O atoms. T. YAMANOUCHI AND M. KOTANI. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp*. 60–76, *Jan*., 1940. —It is generally assumed that atomic O is relatively abundant in certain regions of the upper atmosphere, since in the spectra of the aurora and of the night-sky light fairly strong lines are observed which are due to forbidden transitions ${}^1S \rightarrow {}^1D$ and ${}^1D \rightarrow {}^3P$ of the neutral O atom. These O atoms, as well as other molecules, may occasionally be ionized by the sun's u.v. radiations and may contribute to the formation of the ionized layer (ionosphere). Moreover, if the ion is formed in a doublet state, recombination may produce an O atom in metastable singlet states ${}^1S$, ${}^1D$, which are upper states of the above forbidden transitions. The authors now calculate quantum-mechanically the ionization and recombination probabilities of the O atom, as functions of energies of the light quantum and the electron. It is found that probabilities of recombination of ions in the ${}^2D$ and ${}^2P$ states are of the same order of magnitude, and hence are very small compared with the probability of forbidden transitions of the ion ${}^2D \rightarrow {}^4S$, ${}^2P \rightarrow {}^4S$. This makes the production of metastable O atoms by photo-ionization and recombination very improbable, at least in the terrestrial atmosphere. H. H. Ho.

1813. Action of metals on photographic plates. J. A. REBOUL. *J. de Physique et le Radium*, **1**, *pp*. 56–62, *Feb*., 1940.—A photometric study of the effect at a distance exerted by metals on a photographic plate (Russell effect) has enabled the author to obtain quantitative results. The results show that Russell's explanation—that the effect is due to oxygenated water produced by the contact of wet air with the metal is insufficient to account for the phenomenon. It is necessary to suppose the existence of a very absorbable radiation emitted by the metal. J. E.

***1814. Resolving power and theory of pinhole camera.** L. A. TURNER. *Am. J. Phys.*, **8**, *pp*. 112–115, *April*, 1940.—The utility of the pinhole camera for teaching photography is emphasized and an improved theoretical treatment put forward. It is shown that the optimum diameter a of the pinhole is given by the expression $a = 2[K\lambda vu/(u+v)]^{\frac{1}{2}}$, where λ = wavelength of the light, u = distance of object to pinhole, v = that of plate to pinhole, and K a numerical factor near to unity. The value of K can be determined theoretically only by postulating some criterion for best definition, but there is no such criterion which is obviously the correct one—hence apparent contradictions in the text-book treatments. Maximum resolving power demands K = 1·2, and best definition K = 0·9, so that the best definition and resolving power are not to be had together. If the quality of the picture is to be good as that considered satisfactory in making depth of focus tables, the hole-to-plate distance must be > 45 cm. S. J. G.

1815. U.v. characteristics of photographic materials. J. R. LOOFBOUROW. *Inst. Divi Thomae, Studies*, **2**, *pp*. 227–231, *Nov*., 1939.—A study is being made of various emulsions from the standpoint of the variation of sensitivity, contrast and reciprocity law failure with wavelength in the u.v. region. The present contribution deals with the variation of contrast with wavelength for Eastman Par Speed Portrait Film. It is found that decreasing contrast below 2 400 Å renders essential the use of fluorescent materials for match point spectrophotometry whilst from 2 500 to 3 600 Å the uniformity of contrast and density for equal exposure times makes the emulsion well suited for this type of work. A. H.

1816. Sensitometric criteria for effective speeds of negative films. L. A. JONES AND C. N. NELSON. *Kodak Research Lab., Comm. No.* 748. *J.O.S.A.*, **30**, *pp*. 93–109, *March*, 1940. *Phot. J.*, **80**, *pp*. 152–168, *April*, 1940.—The effective camera speed (S) should be evaluated in terms of the minimum exposure which will yield a negative from which a print of excellent quality can be made [see Abstract 1636 (1939)]. A method of determining S has been devised, the basis being the usual curve of negative density *versus* log exposure: the S of the material is then expressed in terms of the exposure corresponding to the point on this curve at which the gradient is 0·3 times the average gradient of the used portion of the curve. The method has been tested on a wide variety of materials from 19 manufacturers, and is found to give excellent correlation with the results of a statistical psycho-physical evaluation of S in which prints were judged by 200 observers. The authors claim that this "fractional gradient criterion" is the best so far devised for expressing speed. S. J. G.

1817. Low-intensity reciprocity law failure in photographic exposure. J. H. WEBB AND C. H. EVANS. *Kodak Research Lab., Comm. No.* 687. *Phot. J.*, **80**, *pp*. 188–192, *May*, 1940.—A study of the low-intensity reciprocity law failure in photographic exposure was carried out by means of a series of equal energy exposures made partly with high-intensity and partly with low-intensity illumination. The high- and low-intensity parts were given in different time order. The results indicate that the low-intensity reciprocity law failure is due to a regression of the latent image speck in its initial stages of formation, while it is still small. If the speck is built up to a stable size by a primary high-intensity exposure, then subsequent exposure at low intensity can continue to build up the speck as efficiently as exposure at high-intensity. The results show that there can exist a latent image speck, which is stable, but which is not yet developable. [See Abstract 3688 (1938).] AUTHORS.

1818. Colour photography by additive method. J. F. H. CUSTERS. *Philips Techn. Rev.*, **5**, *pp*. 48–54, *Feb*., 1940.—The principles and the natural limitations of the photographic reproduction of colours are discussed. On the basis of a fundamentally very simple method of colour reproduction, in which pictures in three colours are projected over one another, the importance for faithful reproduction of a strict linear relation between the amounts of light at the beginning and the end of the whole photographic process is pointed out. The requirement of linearity can be satisfied when the photographic materials used in combination for negative and positive transparency have certain characteristics. In particular it is desirable that the transmission curves of the two materials should be mirror images of each other, as pointed out by Kremer. Various methods are described by which such transmission curves can be realized practically. The methods described have been tested in the Philips Laboratory with different photographic materials, and it has been found that a faithful colour reproduction can be obtained with it for all practical purposes. [See also Abstract 3146 (1937).]

***1819. Tone rendering by vignetted or contact screens.** F. J. TRITTON AND E. T. WILSON. *Phot. J.*, **80,** *pp.* 59–69 ; *Disc.*, 69–71, *March*, 1940. —Details are given of the authors' preparation of vignetted screens, the various defects and their elimination being dealt with. Details are also given of the authors' investigation—both theoretical and practical—of tone rendering produced by the screens. It is concluded that so far as tone rendering is concerned any result which can be achieved with a vignetted screen can equally well be obtained with a crossline screen used in the camera, and the latter technique is more adaptable because a screen of different contrast range is not required for each class of original. Taking into account, however, such points as the speed of making screen negatives, ability of unskilled operators to use vignetted screens and the advantage of being able to make a screen negative without a camera, etc., there may be a commercial future for vignetted screens, particularly in newspaper work, if the problem of eliminating dust spots and other defects be solved. S. J. G.

See also Abstracts 1800, 1866.

PHOTOMETRY.

1820. Clarification of definitions of light quantities for flashes. J. A. M. VAN LIEMPT AND J. A. DE VRIEND. *Physica*, **7,** *pp.* 255–264, *March*, 1940. *In German.*—Gives a review of the different constants and factors arising when measuring light quantity from short flashes of light. The items dealt with particularly include the total flash time, the practical flash time and the 50% time and also the light output quantities. E. O. T.

***1821. Recording microphotometer.** H. LLOYD AND E. M. GUÉNAULT. *Journ. Sci. Instruments*, **17,** *pp.* 103–111, *May*, 1940.—The paper describes a recording microphotometer of compact design. The plate or film under investigation rests on a moving horizontal stage driven by a governor-controlled clockwork motor and coupled to a recording drum. The optical system is vertical and employs a photronic cell connected directly to a taut-suspension reflecting galvanometer whose deflections are recorded photographically on the revolving drum. In addition to its use in spectrophotometry the instrument has been employed for the measurement of X-ray diffraction negatives and as a recording densitometer in connection with a survey of low illuminations by photographic photometry. AUTHORS.

See also Abstract
1066B. New luminous standard. G. Heller.

POLARIZATION.

***1822. Brace half-shadow method.** G. SZIVESSY AND W. HERZOG. *Phys. Zeits.*, **41,** *pp.* 43–46, *Jan.* 15, 1940.—Reference is made to a paper by Björnståhl [see Abstract 3663 (1939)] who has apparently overlooked

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the authors' paper on the formulae for the Brace compensator [see Abstract 2070 (1937)] which includes a correction of the errors in previous presentations of Brace's method. The disadvantages of the Brace method as compared with the simplified half-shadow apparatus [see Abstract 4980 (1935)] are discussed and Björnståhl's views are criticized. G. E. A.

See also Abstract 1798.

REFLECTION, REFRACTION AND DISPERSION.

1823. Optical properties of potassium films. D. HACMAN. *Soc. Roumaine de Physique, Bull.*, **40**, 74, *pp.* 77–97, 1939. *In German.*—The author determines the optical transmission and reflection factors between 2 500 and 5 000 Å for potassium layers of thicknesses varying from 0 to over 30 mμ. These layers are deposited, in very high vacuum, on a transparent silica window by the method of atomic rays. The monochromatic, unpolarized radiation falls on the layer under an incidence angle of 30°. The author studies the variation of the form of the optical maximum of absorption (A) for 3 800 Å, with the thickness of the metal layer. The results thus obtained are analysed in relation to the structure and the photo-electric properties of very thin potassium layers. From the data, the optical constants n and k for some of the thin layers thus studied and the dispersion curve for a 30 mμ thick layer, are deduced. AUTHOR.

1824. Non-Cartesian mirror, refracting surface and lens treatment. E. J. IRONS. *Phys. Soc., Proc.*, **52**, *pp.* 281–311, *May*, 1940.—The paper contains a detailed account of a treatment of reflection and refraction based on a sign convention which involves the convergence and divergence of beams of light, and gives positive signs to the powers of concave mirrors and convex lenses situated in air. The essence of the treatment is given in four rules which are applied both to single and multiple reflecting and refracting surfaces, and substantiated by proofs which involve finite objects and both convergent and divergent incident light. The treatment includes a discussion of Newton's formula and the cardinal points of a lens system, and there are appended the solutions of ten problems to illustrate the use of the method proposed. AUTHOR.

1825. Infra-red refraction of CH_4 and dipole moment of CH bond. R. ROLLEFSON AND R. HAVENS. *Phys. Rev.*, **57**, *pp.* 710–717, *April* 15, 1940. —The index of refraction of CH_4 has been measured for 49 different wavelengths in the infra-red between 1 and 15 μ. These data have been interpreted in terms of the active infra-red frequencies of CH_4, and yield what may be considered estimates of the dipole moment of the CH bond and the rate of change of this moment with CH distance. The measurements show that the infra-red bands are only about one-sixth as strong as would be necessary to remove the discrepancy between $n_\infty - 1$ as obtained from indices of refraction measured at optical wavelengths and extrapolated to infinite wavelength, and $\epsilon - 1$ as determined from dielectric constant measurements. AUTHORS.

1826. Calculation of refractivity of glasses. O. KNAPP. *Soc. Glass Technol., J.*, **24**, *pp.* 37–40, *Feb.*, 1940.—The author refers to his previous work and then examines the accuracy with which the refractive index of glasses can be calculated from Gilard and Dubrul's constants, the data for 67 optical glasses being utilized for the purpose. AUTHOR.

1827. Physics in the glass industry. W. E. S. Turner. *Nature*, **145**, *pp*. 446–448, *March* 23, 1940.—Survey of discussion held recently by the Institute of Physics. A. H.

See also Abstracts 1711, 1894.

SPECTROSCOPY.

***1828. Iron arc as standard source for spectrochemical analysis.** M. Slavin. *Indust. and Engin. Chem* (*Analytical Edition*), **12**, *pp*. 131–133, *March*, 1940.—A study is made of the iron arc as a constant reproducible light source used as an external standard. After investigating effect of current and voltage variations, etc., it is concluded that, provided the optical set-up is not disarranged, a series of exposures should be reproducible to 1%. An impermanent set-up should give a reproducibility of 3%. A. H.

1829. Effect of pressure on wavelengths of international secondary standards in Fe I spectrum. C. J. Humphreys. *Bureau of Standards, J. of Research*, **24**, *pp*. 389–393, *April*, 1940.—The wavelengths of the lines in the first spectrum of iron, adopted as secondary standards by the I.A.U. in 1928 and 1938, have been compared with the wavelengths of the same set of lines, observed by Burns and Walters using a vacuum-arc source. The international standard wavelengths are derived from observations with the specified Pfund arc operated in air. Consequently the two sets of data permit a check on the pressure effect in Fe I. Term depressions obtained by this comparison agree reasonably well with those observed by Babcock. Author.

1830. Electrical quadrupole moment of the deuteron. Radiofrequency spectra of HD and D_2 molecules in a magnetic field. J. M. B. Kellogg, I. I. Rabi, N. F. Ramsey, Jr., and J. R. Zacharias. *Phys. Rev.*, **57**, *pp*. 677–695, *April* 15, 1940.—The molecular-beam magnetic-resonance method has been applied to study the radiofrequency spectra of the molecules D_2 and HD, in the state $J = 1$. All the measurements were made in applied magnetic fields large enough to decouple the angular momentum vectors concerned. The spectrum of D_2 for the transitions $m_1 = \pm 1$ consists of 6 lines as in H_2. The HD spectrum consists of two sets, one of 9 lines in the region of the Larmor frequency of the proton, and another of 12 lines in the region of the Larmor frequency of the deuteron. The analyses of these spectra into sets of energy levels and a consistent theory are presented. As a consequence of the analysis one has to assume the existence in the deuteron of an electrical quadrupole moment, Q. The other quantities which are evaluated from these measurements are the spin-orbit interaction constants for the molecules concerned and the magnetic moments of the proton and deuteron, through the magnetic dipole-dipole interactions. The values of the constants are $Q = 2{\cdot}73 \times 10^{-27}$ cm^2., $H'(D_2) = 14{\cdot}0$ gauss, $H'_D(\mathrm{HD}) = 20{\cdot}1$ gauss, and $H'_P(\mathrm{HD}) = 20{\cdot}48$ gauss. These spin-orbit interaction constants represent the magnetic field produced by the molecular rotation at the position of a nucleus. The values of the magnetic moments of the proton and deuteron agree with the direct measurements previously reported. [See Abstract 4578 (1939).] Authors.

1831. Infra-red absorption spectrum of monochlorsulphonic acid. S. Vencov and D. Stefănescu. *Soc. Roumaine de Physique, Bull.*, **40**, 74, *pp*. 45–56, 1939.—The infra-red absorption spectrum of SO_2HCl is studied between 2·5 and 9 μ. Eight new bands are found, of which

7 belong to S-Cl (4 fundamentals and 3 harmonics) and one (harmonic) to S = O. The above attributions are made possible, in spite of the dissymmetry of the molecule, by comparison with Raman spectra of SO_4H_2 and of the sulphates. AUTHORS.

1832. Tail bands of Deslandres-D'Azumbuja system of the C_2 molecule. G. HERZBERG AND R. B. SUTTON. *Canad. J. of Research, A,* **18,** *pp.* 74–82, *April,* 1940.—A number of new bands of the C_2 molecule are analysed and found to represent tail bands of the Deslandres-d'Azambuja system. In consequence of the extension of this system thus obtained it was possible to improve considerably on the values of the rotational and vibrational constants of the upper and lower states $^1\Pi_g$ and $^1\Pi_u$ respectively. The vibrational quanta of the upper state are found to decrease rather rapidly, and a short extrapolation leads to a dissociation limit at 35 900 cm^{-1}. above the lower state $^1\Pi_u$. From this and a recently suggested $D_0(C_2)$ value, the energy difference between the $^1\Pi_u$ state and the $^3\Pi_u$ ground state is determined to be 13 700 cm^{-1}. = 1·7 eV. [See Abstract 4541 (1937).] AUTHORS.

1833. Determination of C-H frequencies (~3 000 cm^{-1}.) in paraffins and olefins. J. J. FOX AND A. E. MARTIN. *Roy. Soc., Proc. A,* **175,** *pp.* 208–233, *April* 10, 1940.—Infra-red absorption spectra of some 20 hydrocarbons in CCl_4 solution are studied in the region 2·6 – 3·8μ. $=CH_2$ groups in ethylene and higher olefins give rise to two CH frequencies (3 079 and 2 978 cm^{-1}.) corresponding to unsymmetrical and symmetrical valency vibrations of the CH_2 group. $\gg$ CH groups in olefins have a single CH valency frequency (3 019 cm^{-1}.). $> CH_2$ groups normally have two valency vibrations (2 926 and 2 853 cm^{-1}.). CH_3 groups are found to have two main CH valency frequencies. CH force constants are given for 11 varieties of CH bond. A. H.

1834. Influence of foreign substances on absorption of dyestuffs in solution. S. MITRA. *Indian Journ. Phys.,* **13,** *pp.* 397–405, *Dec.,* 1939.—The phenomenon of quenching of the fluorescence of the dyestuffs, fluorescein, eosin and rhodamine B in solution with the addition of different amounts of KI has been studied. The results are shown graphically. AUTHOR.

1835. Absorption spectra of N-substituted auramine dyes. G. BREUER AND J. SCHNITZER. *Chem. Soc., J., pp.* 461–463, *April,* 1940.—The absorption spectra of auramine and N-substituted auramines, their hydrochlorides, and picrates are recorded for the range 2 000–5 300 Å. AUTHORS.

1836. U.v. spectrum of paraffins and vaselines. E. VELLINGER AND B. THOMAS. *Comptes Rendus,* **210,** *pp.* 296–297, *Feb.* 19, 1940.—Crystalline paraffins extracted from petrol exhibit u.v. absorption about 100 times greater than that of a paraffin oil from which all aromatic compounds have been removed by treatment with oleum. It is therefore probable that these crystalline hydrocarbons contain aromatic compounds, more or less highly substituted. Vaselines distilled *in vacuo* also gave fractions which showed strong u.v. absorption. A. J. M.

1837. Properties common to hydrogenated molecules. H. DESLANDRES. *Comptes Rendus,* **210,** *pp.* 277–281, *Feb.* 19, 1940.—The new method of analysis of molecular spectra previously described [see Abstract 767 (1940)] is applied to more complicated molecules containing H:— HN_3, C_3H_5, $C_{10}H_{16}$, gallic acid, tyrosine and raffinose. The observed frequencies correspond to three possible ways in which the molecules can divide into two resonating parts, viz.: — H — (M–H), H_2 — (M–2H), H_3 — (M–3H). It is also suggested that, in 6 cases previously described where the frequencies of liquid and gas states are respectively integral multiples of the same common factor, the liquid molecules are polymers of the gas molecules. **Errata,** *ibid.*, *p.* 423, *March* 11, 1940. C. B. A.

1838. Vibrational analysis of absorption spectrum of furan in Schumann region. L. W. Pickett. *J. Chem. Phys.*, **8,** *pp.* 293–297, *April*, 1940.—The absorption spectrum of furan vapour between 2 200 and 1 550 Å shows 3 band systems which overlap slightly. The second of these with a 0 — 0 band at 52 230 cm^{-1}. has sharp bands which could be analysed to reveal three prominent totally symmetrical vibration frequencies of the excited molecule of 1 395 cm^{-1}., 848 cm^{-1}. and 1 068 cm^{-1}. Other characteristic frequency differences in the more diffuse bands are noted. Since the furan was found to be comparatively stable to photochemical decomposition, measurements of the intensity of absorption were made. Author.

1839. Band spectrum of SbCl. W. F. C. Ferguson and I. Hudes. *Phys. Rev.*, **57,** *pp.* 705–707, *April* 15, 1940.—A band spectrum attributed to the molecule SbCl, in the region λλ4 200–5 600, has been excited by introducing $SbCl_3$ into active N. No other bands appeared in the range λ2 000 to λ7 000. The spectrum consists of bands showing pronounced progressions and degraded towards the red. They can be placed in two sub-systems of bands, designated as A_1 and A_2. Vibrational analysis shows that within experimental error the wave numbers of the heads of 41 bands of $SbCl^{35}$ are represented by the formulae:

$$A_1 : \nu_1 = 22\,395 + 244{\cdot}4u' - 2{\cdot}28u'^2 - 368{\cdot}0u'' + 0{\cdot}84u''^2,$$
$$A_2 : \nu_2 = 25\,855 + 240{\cdot}2u' - 2{\cdot}19u'^2 - 370{\cdot}0u'' + 1{\cdot}00u''^2.$$

The Cl isotope effect appears in 13 bands and is used to confirm the v', v'' designations. The analysis of the spectrum given here is somewhat different from that originally presented two years ago. Many more bands are here accounted for and identified. An attempt failed to produce a spectrum of AsCl by introducing $AsCl_3$ vapour into active N. Authors.

1840. Near infra-red spectra of PbH and SnH. W. W. Watson and R. Simon. *Phys. Rev.*, **57,** *pp.* 708–709, *April* 15, 1940.—Revised calculations of energy constants of the PbH molecule are presented as a result of analyses of bands in the photographic infra-red. Former v' values are raised by one unit. An isolated weak PbH band is found at 3 815 Å. Additional SnH bands in the red produced in the high pressure arc are briefly discussed. Authors.

1841. Band spectrum of SnTe in emission. R. F. Barrow. *Phys. Soc., Proc.*, **52,** *pp.* 380–387, *May*, 1940.—In continuation of the work on u.v. band systems of the diatomic group-IV(b) + VI(b) molecules, the band spectrum of SnTe has been obtained in emission by a heavy-current uncondensed discharge through a mixture of Sn, Te and Al in a silica discharge tube. About 45 bands have been observed and measured in the region λλ3 575 to 4 235, of which 26 have been assigned to a main system A → X. Band heads of this system are represented by the equation $\nu_{head} = 25\,451{\cdot}7 + (177{\cdot}4u' - 0{\cdot}13u'^2) - (263{\cdot}7u'' - 1{\cdot}1u''^2)$. Bands on the short-wavelength side of this system appear to belong to an incompletely developed system involving X, which is probably the ground state. Heads increasingly distant from their respective system-origins become increasingly diffuse owing to the vibrational isotope effect, which is briefly described. The relations of the electronic and vibrational constants of SnTe to those of the analogous oxides, sulphides, selenides and tellurides of Sn and Pb are reviewed, together with the problem of the correlation of the upper states of these molecules. [See Abstracts 1677 (1939) and 173 (1940).] AUTHOR.

1842. Second positive band-system of nitrogen. R. C. PANKHURST. *Phys. Soc., Proc.*, **52**, *pp.* 388–389, *May*, 1940.—New measurements are given of the heads of the second positive band-system of nitrogen. The measurements are believed to be accurate to 0·1 Å, an accuracy which should be sufficient for identification of the system. A. H.

1843. Predissociation of several diatomic molecules. G. HERZBERG AND L. G. MUNDIE. *J. Chem. Phys.*, **8**, *pp.* 263–273, *March*, 1940.—The observed intensity distribution in the S_2 bands indicates that the dissociation limit for the first predissociation lies appreciably below the predissociation limit (4·4 eV); this is not a case of pressure broadening. The second predissociation starting with the 18–0 band leads to an upper limit of 3·6 eV for the heat of dissociation of S_2. An anomalous intensity distribution similar to that of S_2 is found for NO, and indicates a predissociation in the upper $^2\Sigma$ state of the γ bands into normal atoms with a limit 1·3 eV above the dissociation limit. The intensity distribution in the CuH emission band λ4 280 at low pressure is explained as due to a predissociation into the $^3\Sigma^+$ state derived from normal Cu(^2S) and normal H(^2S). The heat of dissociation of CuH is $< 2{\cdot}892$ eV. From the breaking off points observed in the visible bands of AlD(AlH) and BH molecules it is established that their $^1\Pi$ states have potential curves with maxima, and thus the dissociation energies are appreciably lower than the energies of the observed breaking off points. N. M. B.

1844. Intensities of electronic transitions in molecular spectra. Part IX. Calculations on long wavelength halogen spectra. R. S. MULLIKEN. *J. Chem. Phys.*, **8**, *pp.* 234–243, *March*, 1940.—The dipole strength D_{NQ} for the perpendicular type $N \rightarrow Q$ transitions in the long wavelength spectra of the halogen molecules is computed on *LCAO* and *AO* approximations for the wave functions. The work illustrates the behaviour of antisymmetrical wave functions in transition moment calculations, and justifies the ignoring of closed shells. The calculated D_{NQ} values for both approximations show the same rapid variation with atomic number as do the observed values, except for I, where the anomalous smallness of the observed value may be due to strong case *c* effects. The *LCAO* calculated values are consistently much larger than the *AO* values, and the latter agree well with experimental values. The calculations show D_{NQ} to be very sensitive to variations of the internuclear distance and of the effective charge Z^* in the Slater atomic orbitals used; the effects of various improvements of the wave functions used is discussed. Calculations for H_2^+ indicate that to improve molecular wave functions Z^* should be increased for bonding but decreased for antibonding molecular orbitals. [See Abstract 4056 (1939).] N. M. B.

1845. Correlation of upper electronic states of homologous molecules. R. F. BARROW. *Faraday Soc., Trans.*, **36**, *pp.* 624–625, *May*, 1940.—The author plots the roots of the products of the ionization potentials of diatomic alkali-metal molecules against the electronic energy for upper electronic states. The points appear closely grouped around straight lines. The lines correlate the upper electronic states of different molecules which are, as far as has been determined, of the same theoretical type. L. K.

1846. Raman effect in arsenates and heat of dissociation of As-O. S. M. Mitra. *Indian Journ. Phys.*, **13**, *pp.* 391–396, *Dec.*, 1939.—The Raman spectra of arsenates in solution are investigated and the four lines with $\Delta\nu$ equal to 349, 827, 878 and 463 cm^{-1}. are assigned to the AsO_4 ion. The binding force between As and O is calculated and the heat of dissociation determined. Author.

1847. Raman spectra of coumarins and chromones. A. Mookerjee and J. Gupta. *Indian Journ. Phys.*, **13**, *pp.* 439–444, *Dec.*, 1939.—The Raman spectra of three coumarins and two chromones, including the parent bodies, have been recorded. A significant difference of more than 50 wave-numbers has been observed in the maximum non-hydrogen frequencies (1 600–1 700 cm^{-1}.) of the two series of compounds. It has been suggested that the examination of Raman spectra can be undertaken to differentiate easily a chromone body from a coumarin, even if they are strictly isomeric, either of which may be formed in some well-known synthetic reactions of organic chemistry. Authors.

1848. Raman spectra of tungstates. M. Théodoresco. *Comptes Rendus*, **210**, *pp.* 175–177, *Jan.* 29, 1940.—The Raman spectra are reported for $Na_2WO_4,2H_2O$, and $SrWO_4$ respectively. Both substances were examined in the crystalline state, and the former in solution as well. The spectra obtained in the 3 cases were sufficiently similar for the author to conclude that the lines observed belonged to the ion WO_4^{--}, and that it is probably a tetrahedron, more or less deformed. A. C. M.

1849. Raman spectra of some metatungstates in the crystalline state and in aqueous solution. M. Théodoresco. *Comptes Rendus*, **210**, *pp.* 297–299, *Feb.* 19, 1940.—The Raman spectra of the metatungstates of Na and Ba have been investigated in the solid state and in solution. The results show that these compounds are perfectly definite, since they possess a characteristic Raman spectrum, which differs from that of the neutral tungstates. A. J. M.

1850. Effect of temperature on Raman spectrum of quartz. T. M. K. Nedungadi. *Indian Acad. Sci., Proc. A*, **11**, *pp.* 86–95, *Feb.*, 1940.—The following frequencies are found in quartz at room temperature:—127, 207, 263, 354, 397, 453, 465, 501, 694, 794, 805, 1064, 1082, 1158 and 1228. 263, 794 and 805 disappear in longitudinal scattering along the optic axis (incident light not polarized). As the temperature is raised from that of liquid air to 530°C., all the lines broaden and decrease in frequency. 207 broadens enormously at high temperatures, disappearing in a continuum. It is concluded from this and from other physical evidence that the mode of oscillation involved in 207 is responsible for the transition from α to β quartz A. C. M.

1851. Raman spectra of aqueous solutions of HCl. L. Ochs, J. Guéron and M. Magat. *J. de Physique et le Radium*, **1**, *pp.* 85–89, *March*, 1940.—Raman spectra are obtained for aqueous solutions of HCl for concentrations up to 19 *N* at ordinary temperatures. The appearance of a band ascribed to HCl associated with water in a quasi-crystalline structure is discussed. The modifications in the water-bands themselves are described. The theory of the hydrated proton is discussed, in relation to these results. A. C. M.

1852. Raman spectra of cholesterol and of cholic acid. C. Sannié. *Comptes Rendus*, **210**, *pp.* 400–402, *March* 11, 1940.—The cholesterol was in solution in CCl_4. Between 800 and 1 300 cm^{-1}., there are a number of feeble bands, and one more intense at 1 135 cm^{-1}. These correspond to the existence of long cyclic saturated chains. Between 1 300 and 1 500

cm^{-1}., the spectrum is analogous to that of carvomenthol, but with a displacement to the red of about 20 cm^{-1}. A band at 1 670 cm^{-1}. confirms the existence of a double bond in a cycle. The cholic acid was examined in the form of a 30% solution in water of sodium cholate. The spectrum has only a vague resemblance to those of cholesterol and the terpenes.
A. C. M.

1853. Raman spectra of substituted cetimines. R. Cantarel. *Comptes Rendus*, **210**, *pp.* 480–483, *March* 27, 1940.—The linkages C = O and C = C are both characterized by frequencies between 1 500 and 1 700. The author sought to determine the frequency corresponding to C = N. He worked on diphenylcetimine, benzophenone, benzhydrylamine, benzhydrylidene-benzylamine, and benzhydrylidene-benzhydrylamine. He concludes that the C = N frequency lies between those due to C = O and C = C, and nearer to the former. By examining the spectrum of benzylidene-benzhydrylamine, and comparing it with that of benzhydrylidene-benzylamine, he finds that the transition from $C_6H_5 - CH = N - CH < (C_6H_5)_2$ to $(C_6H_5)_2 > C = N - CH_2 - C_6H_5$ causes a considerable modification in the Raman spectrum, so that it can be used with advantage for investigating the equilibrium of these two isomers. A. C. M.

1854. Calculation of vibration frequencies of sym-$C_6H_3D_3$, p-$C_6H_4D_2$, and p-$C_6H_2D_4$. E. Bernard, C. Manneback and A. Verleysen. *Ann. Soc. Sci. de Bruxelles*, **60**, *pp.* 45–59, *March* 9, 1940.—This is the sequel to the calculation of the constants in the potential function occurring in the plane vibrations of the benzene molecule [see Abstract 1569 (1940)]. The potential function there found, is applied to calculating the vibration frequencies in the above molecules, and the exactness of agreement is confirmation of the correctness of the solution. The function used contains a term representing the coupling between angles and adjacent sides in the ring, and this term is important. There are 16 parameters in the potential function; this is used to calculate 42 frequencies, with an error never greater than 2·1%, while in only 5 cases is the error greater than 1%.
A. C. M.

See also Abstracts 1774, 1776, 1876, 1877, and
928B. Direct photo-electric measurement of spark spectra. W. Meyer-Eppler.

TRANSMISSION.

See Abstract 1920.

X-RAYS.

***1855. Use of cathode-ray oscillograph for measuring X-ray tube voltage.** C. Weyl. S. R. Warren, Jr., and D. B. O'Neill. *Am. J. of Roentgenology and Radium Therapy*, **43**, *pp.* 428–432, *March*, 1940.—An inexpensive portable oscillograph, employing a fluorescent screen, is described for the determination of the voltage across an X-ray tube, which it is claimed is no more expensive than a good sphere gap. The apparatus is described in detail and in respect to use and calibration. Essentially, high resistances with an earthed mid-point are shunted across the X-ray tube. The voltage across a resistance at the mid-point earthed connection, is taken to one pair of the oscillograph plates, with a shunted earthed resistance, the other pair of plates being excited from the mains. The requirements are that no appreciable load is put upon the h.t. generator, the apparatus has low inductance and capacity, so that the wave form is not distorted, the values of the resistances remain constant with time, temperature and humidity, it is easily connected with the h.v. circuit and is portable, these requirements being satisfied by the particular apparatus described. B. J. L.

1856. Intensity distribution in X-ray and electron diffraction patterns. X-ray atom factors of Zn in ZnO and chemical binding. C. H. EHRHARDT AND K. LARK-HOROVITZ. *Phys. Rev.*, **57**, *pp.* 603–613, *April* 1, 1940.—Electron diffraction patterns of ZnO show intensities deviating markedly from those calculated under the assumption of a spherically symmetrical electron distribution in the atom. For a final decision between various possible explanations, X-ray diffraction patterns from a flat sample of ZnO were obtained photographically, with monochromatic Cu $K\alpha$ radiation, and the relative intensities measured. From these results calculated X-ray atom factors for Zn and theoretical electron diffraction curves are obtained. These reproduce the essential features of experimental data, and hence the observed intensity anomaly must be due to anomalous F factors in the expression for electron diffraction intensity $(Z-F)^2[(\sin\theta)/\lambda]^{-4}$ rather than to effects of dynamical reflection neglected in the kinematic theory. Discrepancies at larger values of $(\sin\theta)/\lambda$ are discussed in connection with temperature and order-disorder effects, together with anomalies due to other factors. N. M. B.

1857. Effect of valency electrons and electron cloud distortion on intensities in electron and X-ray scattering. V. A. JOHNSON. *Phys. Rev.*, **57**, *pp.* 613–621, *April* 1, 1940.—The intensity distribution, determined photographically, of electrons scattered by ZnO shows marked anomalies with respect to the intensity distribution of the corresponding X-ray pattern. The observed diffraction pattern intensities are accounted for by assuming a polarization of the M shell of the Zn atom, and this hypothesis is tested by calculating the charge distribution of the M shell in Zn under the effect of the electrostatic fields arising from a partly ionic character of the lattice and its deviation from perfect tetrahedral symmetry. The calculated distortion is too small by a factor of 1/160 to account alone for the observed anomalies. The effect due to the valency electrons is then considered. A model in which two valency electrons of each Zn-O pair of nearest neighbours are assumed to be distributed over the surface of an ellipsoid, with major axis along the c axis of the crystal, accounts for the principal anomalies in the electron diffraction intensities and gives results in agreement with measured X-ray intensities. N. M. B.

1858. L-emission and absorption spectra of Th. Y. CAUCHOIS AND M. L. ALLAIS. *J. de Physique et le Radium*, **1**, *pp.* 44–50, *Feb.*, 1940.—Careful analysis of the L-emission spectrum of Th, including measurements of all strong lines, reveals the presence of numerous weak dipole, quadrupole or forbidden lines, as well as " satellites", which are recorded with as much accuracy as their intensities permit. A special study is made of emission from the P-levels, and the absorption edges and their structure are analysed. The energy values of all the Th levels which are concerned in normal X-ray emission are determined. They differ considerably from those usually accepted in some cases, but are useful in the interpretation of the spectra of the heavy elements. C. B. A.

1859. Effects of chemical combination on Kβ-lines of Cl. H. TAZAKI AND M. HUZITA. *Hirosima Journ. Sci.*, **10**, *pp.* 73–75, *March*, 1940.—Owing to the previous discovery [see Abstract 5177 (1936)] of several weak non-diagram lines in the $K\beta$ spectrum of Cl, in combination, the wavelengths of these lines have been redetermined using Cl in the following compounds :—$MgCl_2$, $AlCl_3$, $KClO_3$, $CaCl_2$, CuCl, $BaCl_2$, $KClO_4$, and $NaClO_3$. Some interesting variations in the wavelengths have been found. G. O. B.

***1860. Concave spherical crystals of barium-copper-stearate for use in long wavelength X-ray spectrometers.** C. L. ANDREWS. *Rev. Sci. Instruments*, **11**, *pp.* 111–114, *April*, 1940.—To perform the double function of diffracting and focusing a monochromatic beam of X-rays, multiple monomolecular layers of barium-copper-stearate were deposited upon an accurately ground concave spherical surface of glass. With a spherical crystal of radius 218 cm., grating space of about 50·5 Å, preliminary photographs of the Al *Kα,β* region, component lines not resolved, were obtained in 30 min. at 3 kV and 15 mA. It is believed that the intensity and resolving power from such a spherical grating are adequate for measurements with an ionization chamber of absorption coefficients at wavelengths above 8 Å. AUTHOR.

See also Abstracts

915B. Detection of defects by technical radiography. E. A. W. Müller.
916B. Stress measurement by X-ray method without comparison material. A. Thum, K. H. Saul and C. Petersen.

HEAT.

CALORIMETRY.

***1861. Specific heats of aqueous NaCl and KCl solutions. Part I.** C. B. HESS AND B. E. GRAMKEE. **Part II.** C. M. WHITE. *J. Phys. Chem.*, **44**, *pp.* 483–512, *April*, 1940.—In Part I the construction and operation of a twin adiabatic calorimeter is described in detail. It is a modified form of the calorimeter used by Richards and Gucker [see Abstract 2312 (1925)] and incorporates similar improvements to those made by Gucker in his modified twin calorimeter [see Abstract 2427 (1928)]. The calorimeters consisted of two closed glass Dewar flasks of about 1 l. capacity, and were suspended in a water jacket. The volume of solution used was about 700 cm^3. The heat was supplied by electric heaters and the temperatures were measured by thermo-elements of Cu-constantan. The apparatus was standardized by means of distilled water. With this apparatus the specific heats of KCl and NaCl solutions at 15°, 25°, 35°, and 45°C. were investigated. The concentrations used ranged from 0·01 to 1 *M*. The values obtained for the specific heats at 25°C. compare favourably with results which are believed to be accurate to 0·01%. In Part II measurements of the specific heats of aqueous NaCl solutions at 35°, 38°, 41° and 45°C. are described. The concentrations of the solutions ranged from 0·01 to 0·2 *M*. The values obtained are claimed to be accurate to 0·02%. The investigation was undertaken for two reasons, (*a*) because the specific heat of water is known to pass through a minimum at 38°C. and (*b*) because the work of Hess and Gramkee in Part I on NaCl solutions showed a departure at 45°C. from the usual linear relation between the apparent molal heat capacity and *M*, whilst the results at 35°C. were definitely linear. It is shown that the apparent molal heat capacities follow a linear relation at the different temperatures when plotted against $M^{\frac{1}{2}}$ instead of M. The results of Hess and Gramkee agree with this relationship. The experimental results are presented in tables and figures, and empirical equations are derived by the method of least squares for all data. Agreement between the author's results and those of previous workers is satisfactory. Some theoretical considerations of the experimental curves are also given. S. W.

***1862. Heat capacity of small volume of liquid by piezo-thermometric method. Parts I-III.** J. S. Burlew. *Am. Chem. Soc., J.*, **62,** *pp.* 681–700, *April,* 1940.—A description is given of an apparatus and method for measuring the adiabatic temperature-pressure coefficient $(\partial T/\partial P)_S$ of about 5 ml. of a liquid, and of a weight dilatometer for measuring the coefficient of thermal expansion $(\partial V/\partial T)_P$ of 5 cc. of a volatile liquid over a wide temperature range with an accuracy of about 0·1%. In each case results are given for C_6H_6 and $C_6H_5CH_3$ at 3° intervals from 8° to the respective boiling points. The piezo-thermometric method for c_p is based on the thermodynamic equation $c_p = T/(\partial V/\partial T)_P/(\partial T/\partial P)_S$, and from the data obtained values of c_p for the two liquids over the above range are tabulated and are shown to agree with the results of other investigators. There is no evidence to support the suggestion that C_6H_6 is allotropic.
N. M. B.

1863. Specific heat of tantalum at low temperatures and effect of small amounts of dissolved hydrogen. K. K. Kelley. *J. Chem. Phys.*, **8,** *pp.* 316–322, *April,* 1940.—Specific heat determinations of pure Ta were made in the temperature range 53° to 298°K. and the entropy was found to be $S_{298\cdot 1} = 9\cdot 9 \pm 0\cdot 1$. Ta containing H in amounts ranging from Ta + 0·028 4 H to Ta + 0·095 8 H was shown to behave anomalously, the specific heat having a high maximum in the region 220° to 265°K. depending on the composition. The height of the maximum and the difference in measurable heat content between hydrogenated and normal Ta were shown to be approximately proportional to the amount of dissolved H. The temperature of the maximum increases as the H is increased. After dehydrogenation, the same specific heat was obtained as for the original unhydrogenated material. The density of the dehydrogenated product also was normal, whereas the hydrogenated materials had lower densities. It is postulated that differences in entropy between hydrogenated and pure Ta may be attributed to differences in the number of possible ways of arranging the H particles among the positions in the Ta lattice available at the higher and lower temperatures. Author.

1864. Specific heats at low temperatures of tantalum oxide and tantalum carbide. K. K. Kelley. *Am. Chem. Soc., J.*, **62,** *pp.* 818–819, *April,* 1940.—Specific heat measurements of Ta_2O_5 and TaC were made in the temperature range 53 to 298·1°K. The entropies are $S_{298\cdot 1} = 34\cdot 2 \pm 0\cdot 4$ for Ta_2O_5 and $S_{298\cdot 1} = 10\cdot 1 \pm 0\cdot 1$ for TaC. The free energy of formation of Ta_2O_5 from the elements has been computed as $\Delta F_{298\cdot 1} = -453\,700$. Author.

***1865. Method and instrument for measurement of very small amounts of heat and very small changes of temperature.** S. Zamenhof. *Rev. Sci. Instruments,* **11,** *pp.* 123–125, *April,* 1940.—A thermometer is described which detects temperature changes of the order of 10^{-4}°C. and quantities of heat of the order of 10^{-4} gm. cal. It is essentially a gas or vapour thermometer in which the shift of the top of the meniscus of an indicating

V.4
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liquid is observed through a microscope. The shift is due to changes of the shape of the meniscus while the circumference remains stationary. Hence the sensitivity depends upon the surface tension of the indicating liquid but not on the friction between the liquid and the glass. AUTHOR.

See also Abstracts 1875, 1895.

CONVECTION.

See Abstract 1703.

DILATATION.

1866. Photo-expansion of Cl_2; recombination of Cl atoms. M. RITCHIE AND R. L. SMITH. *Chem. Soc., J., pp.* 394–401, *April,* 1940.—Measurements have been made of the photoexpansion of Cl_2 under various conditions. Possible processes of recombination of Cl atoms have been discussed in relation to diffusion and thermal conductivity factors; results are in agreement with the mechanism $Cl + Cl_2 + M \rightarrow Cl_3 + M$, $Cl_3 + Cl_3 \rightarrow 3Cl_2$. Water vapour in small amounts reduces the photoexpansion very slightly when surface actions are involved. [See also Abstract 5381 (1937).] AUTHORS.

See also Abstract 1862.

FUSION AND SOLIDIFICATION.

1867. Freezing points of system ethylene glycol-methanol-water. F. H. CONRAD, E. F. HILL AND E. A. BALLMAN. *Indust. and Engin. Chem.*, **32**, *pp.* 542–543, *April,* 1940.—Two of the most widely used antifreeze materials at the present time are methanol and ethylene glycol. The possibility of producing an " optimum " antifreeze from a mixture of the two with qualities superior to either alone makes the quantitative determination of the physical properties of this system over the temperature range to which antifreeze mixtures are subjected important. This paper presents results of the freezing point determinations of this ternary system as a function of the composition. AUTHORS.

1868. Freezing points in mixtures of strong electrolytes. M. RANDALL AND B. LONGTIN. *J. Phys. Chem.*, **44**, *pp.* 427–435, *April,* 1940.—Mathematical.

1869. Fluorochloroethanes as solvents for cryoscopic determination of molecular weights. J. BERNSTEIN AND W. T. MILLER. *Am. Chem. Soc., J.*, **62**, *pp.* 948–949, *April,* 1940.—Fluoropentachloroethane, *sym*-difluorotetrachloroethane and *unsym*-difluorotetrachloroethane were shown to be good cryoscopic solvents for non-associated substances. Their large molecular freezing-point depressions, chemical inertness and convenient melting temperatures recommend their use. AUTHORS.

See also Abstract 1874.

TEMPERATURE.

***1870. Direct calibration of copper-constantan thermel.** J. S. BURLEW AND R. P. SMITH. *Am. Chem. Soc., J.*, **62**, *pp.* 701–704, *April,* 1940.—The computations involved in the measurement with a thermel of temperature differences at a series of mean temperatures (t_m) are simplified by the introduction of the function $\mu \equiv \triangle E/(t_2 - t_1) = \alpha + \beta t_m + \gamma t_m^2$. A direct differential method of calibration, whereby the parameters of this equation are evaluated, minimizes the error from inhomogeneity. For the demonstration of the experimental validity of this method, a copper-

constantan thermel that had been calibrated by it was compared with one that had been calibrated by the ordinary integral method; in a series of temperature differences measured with the two thermels the maximum divergence was 0·005°, which was less than the experimental uncertainty.
AUTHORS.

***1871. Fluorescent Hg-vapour lamp as light source for single-point check on optical pyrometers.** C. F. LUCKS AND H. W. RUSSELL. *J.O.S.A.*, **30,** *pp.* 163–167, *April,* 1940.—A simple single-point calibration method for an optical pyrometer is useful for general works use. The fluorescent Hg-vapour lamp is examined and considered to form a useful and suitable source. Factors considered include:— ambient temperature, line voltage changes, lamp current and lamp life. The ambient temperature should be kept approximately constant; lamp current is a better guide than line voltage and lamps should be aged for 100 hr. before calibration. The working temperature is of the order of 2 000°F. Lamps used were of the 15-W pink fluorescent type. Colour temperature is not very critical with variation in lamp current, so that ordinary accuracy is sufficient for the ammeter. Tables and curves of experimental results are given.
E. H. W. B.

***1872. Vacuum thermocouple.** G. E. MOORE AND H. W. WEBB. *Rev. Sci. Instruments,* **11,** *pp.* 101–102, *March,* 1940.—The authors describe improvements in the construction of a vacuum thermocouple of high sensitivity for use in measuring the intensities of spectral lines. The design of the couple, as regards dimensions, materials of the wires, and size of receiver is essentially the same as that used by Brackett and McAlister [see Abstract 2862 (1930)]. Bi alloys and Bi gave the greatest sensitivity but 0·0075 mm. constantan and 0·0125 mm. nichrome were used where a robust rather than a very sensitive thermocouple was required. The sensitivity of such a thermocouple was about half that obtained with Bi alloy wires.
S. W.

***1873. High temperature laboratory furnaces.** M. PIRANI. *Journ. Sci. Instruments,* **17,** *pp.* 112–115, *May,* 1940.—Two laboratory furnaces for temperatures up to 1 900°C. are described. The preparation of the necessary ceramics is discussed.
AUTHOR.

See also Abstracts 1865, 1883, and
980B. Graphite/silicon carbide thermocouple and its applications in metallurgy. M. Bonnot.

THERMOCHEMISTRY.

1874. Heats of solution of some normal organic compounds in dilute aqueous solution. J. PERREU. *Comptes Rendus,* **210,** *pp.* 293–295, *Feb.* 19, 1940.—The molecular heats of solution of normal organic compounds is proportional to the molecular concentration of the solute. Solutions of the following substances were investigated: urea, acetamide, mannite, glucose, sucrose, glycol and glycerol. For very dilute solutions the constant K in the equation $\delta_q = Kp/100\,m$ (δ_q = specific variation of the differential heat of solution, p = weight of solute of molecular weight m, dissolved in 100 gm. of H_2O) is equal to the molecular depression of the freezing point for H_2O. The molecular variation of the differential heat of solution is the same for all normal organic compounds examined (i.e. those which do not dissociate or associate) and the method could be used for the determination of molecular weights in a similar way to the cryoscopic method.
A. J. M.

1875. Heat and free energy of formation of deuterium oxide. F. D. Rossini, J. W. Knowlton and H. L. Johnston. *Bureau of Standards, J. of Research,* **24,** *pp.* 369–388, *April,* 1940.—Calorimetric measurements of the ratio of the heat evolved in the formation of 1 mole of liquid D_2O, from gaseous D_2 and ordinary O_2, to the heat evolved in the formation of 1 mole of ordinary liquid water, from gaseous ordinary H_2 and O_2, yielded the value $1{\cdot}030\,68 \pm 0{\cdot}000\,29$ for 25°C. and a constant pressure of 1 atm. Calorimetric measurements of the ratio of the heat of vaporization of 1 mole of D_2O to that of 1 mole of ordinary water yielded the value $1{\cdot}031\,45 \pm 0{\cdot}000\,75$ for 25°C. and zero pressure.Thermodynamic values obtained by combination of these with other data are given. On the assumption that the bond energies in H^1_2 and D_2 are the same, and likewise in H^1_2O and D_2O, the difference in the zero-point energies of $H^1_2O(g)$ and $D_2O(g)$ was calculated to be $14\,841 \pm 91$ int. j/mole ($3\,548 \pm 22$ cal./mole, or $1\,243{\cdot}0 \pm 7{\cdot}6$ wave numbers). The accord of this value with that recently calculated by Darling and Dennison from the vibrational-rotational spectra of D_2O and H_2O, $1\,245{\cdot}5 \pm 2{\cdot}0$ wave numbers, indicates that, with the assigned limits of uncertainty, the respective bond energies are independent of the mass of the nucleus of the atom. Authors.

1876. Relation between the energy of a hydrogen bond and the frequencies of the O-H bands. R. M. Badger. *J. Chem. Phys.,* **8,** *pp.* 288–289, *March,* 1940.—The frequency shifts which occur in the third harmonic of the O-H band in the region 9 500–11 000 Å when the hydroxyl group enters into a hydrogen bond, have been studied for a number of substances. A diagram shows the relation between these frequency shifts and the bond energy. The relation appears to be not linear. The organic acids are not included in this diagram as their O-H bands show an anomalous behaviour. L. K.

1877. Bond strength and potential energy relationships in acetylene. H. Henkin and M. Burton. *J. Chem. Phys.,* **8,** *pp.* 297–300, *April,* 1940. —The spectroscopic value for the heat of formation of free CH and Herzberg's value for the heat of sublimation of graphite lead to a value of $\sim 137{\cdot}9$ kg./cal. for the $C \equiv C$ bond strength in acetylene. This value is employed in a study of the potential energy levels of that compound and is shown to be the only one consistent with the most recent studies of its absorption spectrum. The fact that the known energy levels of free CH fit into the scheme is further evidence for the $125{\cdot}1$ kg./cal. value for the heat of sublimation of graphite. Authors.

See also Abstracts 1865, 1883.

THERMODYNAMICS.

1878. Empirical equation for thermodynamic properties of light hydrocarbons and their mixtures. Part I. M. Benedict, G. B. Webb and L. C. Rubin. *J. Chem. Phys.,* **8,** *pp.* 334–345, *April,* 1940.—An empirical equation is given for the isothermal variation with density of the work content of pure hydrocarbons in the gaseous or liquid state. From this fundamental equation are derived (*a*) an equation of state, (*b*) an equation for the fugacity, and (*c*) an equation for the isothermal variation of the enthalpy. These equations summarize P-V-T properties of the gaseous or liquid phase, critical properties, vapour pressures, and latent heats of evaporation. A procedure is suggested for determining numerical values of the parameters in the equation. Such values are given for methane, ethane, propane, and *n*-butane. A comparison is made between observed properties of these hydrocarbons and those predicted by the equations. AUTHORS.

1879. Co-existence of liquid and gaseous states of aggregation in the critical temperature region. Part I. Ethane. S. G. MASON, S. N. NALDRETT AND O. MAASS. **Part II. Ethylene.** S. N. NALDRETT AND O. MAASS. *Canad. J. of Research, B,* **18,** *pp.* 103–121, *April,* 1940.—In Part I a careful study has been made of the position and nature of the meniscus and the distribution of opalescence in bombs containing ethane as the critical temperature is approached. Photographs of the phenomena have been made. The effect of shaking has been observed, and a type of shaking is described that is believed to hasten the attainment of equilibrium between the liquid and vapour phases. Using this type of stirring the co-existence curve of ethane has been determined. Relative temperature measurements are accurate to within ± 0·001°C.; absolute temperature measurements, to within ± 0·015°C. Density measurements are believed accurate to within 1 : 3 000. The limiting curve has the classical parabolic shape up to 32·23°C., at which point the slope changes abruptly and the curve becomes flat along the density axis. The authors believe that at this temperature a dispersion of liquid and vapour occurs and that liquid still persists above this temperature. It is shown that the critical temperature as ordinarily determined in a stationary bomb cannot be accurately determined. The critical temperature can be determined precisely and without ambiguity when the bomb is shaken, and it is recommended that the value obtained in this way be used instead, as a physical measurement. In Part II the coexistence curve of ethylene has been determined in a similar manner. It is found to lie entirely within the co-existence curve determined by P-V-T methods by other investigators. This is considered to be evidence for the formation of a dispersion of liquid and vapour before the critical temperature is reached. The term " critical dispersion temperature" is suggested for the temperature at the apex of the co-existence curve determined by the disappearance of the meniscus in a bomb shaken in the manner described in this investigation. The apex of the curve determined by P-V-T methods is the true critical temperature, beyond which liquid is not stable. The classical critical temperature, determined by the disappearance of the meniscus in a stationary bomb, is an indefinite point between these two. AUTHORS.

1880. Calculation of ionic heat capacities in solution. D. H. EVERETT AND C. A. COULSON. *Faraday Soc., Trans.,* **36,** *pp.* 633–643, *May,* 1940.—The possibility of applying statistical mechanics to the calculation of ionic heat capacities has been investigated and applied to the problem of the change in heat capacity accompanying the ionization of acids. It is shown that by considering the influence of the ions on the freedom of rotation of water molecules in their neighbourhood, most of the observed changes may be explained. The values obtained are discussed and possible additional effects which may be of importance are considered. At present further advance in this field is mainly limited by our rather meagre knowledge of the nature of liquid water. AUTHORS.

1881. Isothermal changes in enthalpy for some gases. R. YORK, JR., AND H. C. WEBER. *Indust. and Engin. Chem.,* **32,** *pp.* 388–392, *March,* 1940.—Isothermal changes with pressure of enthalpy for ethane, propane, butane, heptane and steam are correlated by means of the empirical equation $(\mathrm{H}^* - \mathrm{H})_{\mathrm{T}} = \Delta \mathrm{T}_c(\mathrm{T}_c/_{370})^n$, where H is the molar enthalpy, H^* the molar enthalpy extrapolated to zero pressure and T_c the critical

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temperature. Graphs are given from which appropriate values of Δ and n can be derived, and it is believed that the suggested method of correlation is reliable between $T/T_c = 1{\cdot}0$ and $T/T_c = 1{\cdot}8$ and between $P/P_c = 0$ and $P/P_c = 8$ for hydrocarbons having T_c between 300° and 600°K. In such cases the enthalpy change at constant temperature can be estimated from a knowledge of the critical pressure and temperature of the substance. R. W. P.

1882. Thermodynamic properties of methyl chloride. G. H. MESSERLY AND J. G. ASTON. *Am. Chem. Soc., J.*, **62**, *pp.* 886–890, *April*, 1940.—The heat capacity of CH_3Cl has been measured from 12°K. to the boiling point. The melting and boiling points are 175·44 and 248·94°K. respectively (0°C. = 273·16°K.). The heat of fusion is 1 537 cal./mol. and the heat of vaporization is 5 147 cal./mol. at the boiling point. The vapour pressure is represented from the triple point to the boiling point by the equation, $\log_{10} P_{\mathrm{mm.}} = -(1\,822{\cdot}60/T - 9{\cdot}287\,119 \log_{10} T + 0{\cdot}005\,555\,56\,T + 31{\cdot}071\,67$. The triple point pressure is 6·57 int. mm. The entropy in the ideal gas state has been found from calorimetric data to be 54·27 e.u. and 55·94 e.u. at 284·94 and 298·16°K., respectively. The corresponding values calculated from spectroscopic and molecular data are 54·31 e.u. and 55·98 e.u. AUTHORS.

See also Abstracts 1691, 1731, 1732, 1734, 1884, 1888, 1917, and

886B. Enthalpy of saturated steam from 0 to 100°C. and other steam properties. F. G. Keyes.

939B. Thermodynamics of electromagnetic phenomena. L. Kneissler-Maixdorf.

VAPORIZATION AND CONDENSATION.

1883. Boiling point of Se. M. DE SELINCOURT. *Phys. Soc., Proc.*, **52**, *pp.* 348–352, *May*, 1940.—In the long gap between the boiling point of S (444°·60 C.) and the freezing point of Au (1 063°C.) there is no fixed point which can conveniently be used for the routine calibration of thermocouples in terms of the international temperature scale. The boiling point of Se (about 690°C.) is suggested as a possible fixed point in this region, and as a first step towards enabling it to be used for this purpose the precise determination of its value has been undertaken. The determination was carried out in a silica boiling tube similar to that normally used at the sulphur point, having a re-entrant tube fitted with a radiation shield. By connecting the apparatus to a reservoir the variation of the boiling point with pressure over the range of 700 to 800 mm. of Hg was also determined. The measurements were made by means of 3 standard Pt *vs.* Pt-Rh thermocouples calibrated at the freezing points of Au, Ag and Sb. Samples of Se from two sources, and two types of radiation shield, were employed and gave the same result. The value found for the boiling point in terms of the international temperature scale was 684·8 ± 0°·1C. at normal atmospheric pressure, with a variation of 1.08 deg. C./cm. of Hg. AUTHOR.

1884. Vapour-liquid equilibrium. Part V. CCl_4-C_6H_6 mixtures. G. SCATCHARD, S. E. WOOD AND J. M. MOCHEL. *Am. Chem. Soc., J.*, **62**, *pp.* 712–716, *April*, 1940.—The vapour-liquid equilibrium pressure and compositions of $C_6H_6 - CCl_4$ mixtures have been measured at 40 and 70° over the whole composition range, and at 30, 50 and 60° for approximately equimolal mixtures. The densities have been determined at 25°. These measurements are expressed analytically, and corresponding equations are derived for the thermodynamic functions, including the energy and entropy of mixing at constant total volume. These equations show a slight asymmetry and a moderate deviation from regularity, which, on account of the nearly additive volumes, is almost the same at constant total volume as at constant pressure. These results are compared with those obtained previously for mixtures of each of the components with cyclohexane, and approximate equations are derived for the ternary system: benzene-cyclohexane-carbon tetrachloride. [For Part IV see Abstract 214 (1940).] AUTHORS.

1885. Vapour pressures of unsaturated hydrocarbons. A. B. LAMB AND E. E. ROPER. *Am. Chem. Soc., J.*, **62**, *pp.* 806–814, *April*, 1940.—Measurements have been made of the vapour pressures of very pure samples of liquid ethene, propene, 2-methylpropene, 1-butene, *cis*-2-butene, *trans*-2-butene, 1,4-pentadiene and 2-methyl-2-butene over the approximate range 10 to 1 000 mm. by the static method. Equations with three constants have been derived by the method of least squares from the results of these measurements expressing the vapour pressure as a function of the temperature. The vapour pressure of liquid and of crystalline propadiene, its triple point temperature and pressure also have been ascertained. From the least-square equations the normal boiling points and the slopes of the vapour pressures curves at these points as well as the heats of vaporization of these substances as perfect gases have been computed. The authors' vapour pressures, with one or two exceptions, have been found to agree excellently with the Ramsay-Young and the Dühring rules, particularly when in each rule an additional constant is introduced. A general equation has been derived expressing the temperature differential of the vapour pressure at the absolute boiling point as a function of the absolute boiling point. With this equation, too, the authors' data are found to be in excellent agreement. AUTHORS.

See also Abstract 1702.

ACOUSTICS.

1886. Acoustic tube as high-pass filter. L. BRILLOUIN. *Rev. d' Acoustique*, **8**, *pp.* 1–11, *Jan.–June*, 1939.—It is generally considered that the mode of transmission of sound waves along the axis of a tube is of a simple character. Attention is drawn to other possible modes in which the waves have nodal lines in a right section; the tube then acts as a high-pass filter. Such waves may be excited by means of push-pull pistons at one end of the tube. The analogous case in h.f. electromagnetic waves is discussed.

G. E. A.

1887. Propagation of plane sound waves near an absorbing surface. J. BRILLOUIN. *Rev. d' Acoustique*, **8**, *pp.* 97–109, *Jan.–June*, 1939.—A mathematical examination of the types of waves which are compatible with the presence of a porous absorbing surface. A method of producing the waves is suggested, and also a method for measuring the impedance of the absorbing surface. **Erratum,** *ibid.*, *p.* 202, *July–Sept.*, 1939.

G. E. A.

1888. Thermodynamic treatment of propagation of elastic waves. M. PARODI. *Rev. d' Acoustique*, **8**, *pp.* 140–146, *July–Sept.*, 1939.—The propagation of elastic waves is studied for a particular system of punctual masses arranged longitudinally. For this purpose a thermodynamic model is envisaged which has analogous properties, and from which is derived a process for measuring the ratio of the specific heats of a gas. H. H. Ho.

1889. Asymptotic distribution of frequencies of a hollow space and surface tension of an ideal gas. K. Husimi. *Phys. Math. Soc. Japan. Proc.*, **21,** *pp*. 759–768, *Dec.*, 1939.—Rayleigh has given an expression, in terms of ν^3, for the number of natural oscillations in a hollow space which have frequencies less than ν, and a correction term, of the order ν^2, to be added, has been empirically established [see Abstract 1749 (1939)]. The author derives the correction term by a systematic method. A theoretical examination is made of the effect of the new term on a material ideal gas. The pressure due to the surface phase is attributed to the existence of a surface tension which differs from the ordinary kind in that it increases with temperature and proceeds from surface kinetic energy. G. E. A.

1890. Origin of phase difference between pressure- and density-waves during molecular absorption of sound in gases. Simple derivation of dispersion and absorption formulae. O. Nomoto. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp*. 77–90, *Jan.*, 1940. *In German*.—It is shown that the origin of the phase difference between pressure and density waves during molecular absorption of sound in gases has a direct connection with the period of adjustment of the vibrational energy. In addition the formulae of absorption and dispersion are derived by a simple method and agree with those of Kneser and Landau. It is also shown that the period of adjustment β' of these authors is related to the ordinary value β by the equation: $\beta' = \beta C_\infty/C_0$, where C and C_0 are the specific heats for infinitely rapid and infinitely slow changes of volume. G. E. A.

1891. Vibration of metallic discs by rhythmic sublimation. T. Okaya and T. Tobiisi. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp*. 768–786, *Dec.*, 1939.—The effect discovered by Waller in which discs, etc., are set in vibration by applying a stick of solid CO_2 to the disc [see Abstract 1983 (1933)] is examined by the authors for circular metallic discs. These were laid horizontally on three equidistant small discs of rubber, and it was found, using an oscillograph, that there is usually present one predominant frequency and one or two subordinate frequencies which are not harmonics. The case in which the Chladni figure consists solely of nodal circles and nodal diameters is treated analytically, and expressions are derived for the frequencies of the disc. It is confirmed that the addition of one nodal circle raises the frequency by a larger amount than that of two nodal diameters. This may be noted from Colwell and Hardy's tables [see Abstract 444 (1938)]. Results are given for two brass discs, and the observed frequencies agree with those found by the formula. Compound figures are examined. In some cases the nodal diameters do not extend through the centre; this is explained as due to the fact that one of the constituents of the compound system is composed solely of nodal circles. Another group of compound figures is discussed. G. E. A.

***1892. Development of violin.** R. Vermeulen. *Philips Techn. Rev.*, **5,** *pp*. 36–41, *Feb.*, 1940.—A discussion is given of a method of obtaining sufficient amplification of the sound of a solo violin with respect to the accompanying orchestra. The arrangement tested is described and various factors are discussed which would be of importance in its practical application. Author.

1893. Speed and absorption of sound in liquids under pressure. P. BIQUARD. *Rev. d'Acoustique*, **8**, *pp*. 130–139, *July–Sept*., 1939.—Previous work is first briefly reviewed, following which comes the description of an apparatus whereby liquids may be compressed to pressures in the region of 1 000 kg./cm^2. Measurements are then recorded for the velocity of sound and its coefficient of absorption at various pressures in toluene. No conclusions are drawn as yet from the data which are tabulated. H. H. Ho.

1894. Birefringence effects in liquids due to supersonic vibrations. R. LUCAS. *Rev. d'Acoustique*, **8**, *pp*. 121–129, *July–Sept*., 1939.—In addition to the known diffraction phenomena, supersonic waves when traversing liquids may produce birefringence. In the present paper the origin of this phenomenon is treated mathematically as a change in the values of anisotropic tensions consequent on the passage of longitudinal waves in a viscous medium according to the theory of Stokes. These tensions develop an optical anisotropy related to the phenomena of dynamic birefringence of Maxwell. The theory of the paper precedes a detailed description of an experimental investigation of the subject, in which castor oil was employed as the liquid medium. H. H. Ho.

1895. Specific heats and dispersion of supersonic velocity in organic vapours. S. K. K. JATKAR. *Indian Journ. Phys*., **13**, *pp*. 445–449, *Dec*., 1939.—It has been shown that the recent results obtained by Railston [see Abstract 3735 (1939)] for the supersonic velocity at lower temperatures are in agreement with the author's results at higher temperatures in the case of benzene, ethyl alcohol and ethyl ether. The methyl alcohol and CCl_4 vapours appear to have lost the vibrational specific heats below 100 kc./s. In the case of benzene and CS_2 vapours the value of V_0 and V_1 or V at 90° are 200 m./sec., 208 m./sec. and 203 m./sec. and 216 m./sec. respectively. The corresponding values of the specific heats are in agreement with the theoretical values calculated on the basis of the assumption that, in the case of benzene, the deformation vibrational terms and in the case of CS_2, both the deformational and longitudinal vibrational terms disappear from the acoustic cycle. The supersonic velocities in vapours of acetone, chloroform, methylene chloride and ethyl alcohol yield specific heat values, which are higher than those calculated from spectroscopic data on account of uncertain corrections due to saturation. [See Abstract 2590 (1939).] AUTHOR.

1896. Optical method for measuring supersonic absorption in gases and liquids. O. PETERSEN. *Phys. Zeits*., **41**, *pp*. 29–36, *Jan*. 15, 1940.—Measurements of absorption in gases have revealed that in contrast to liquids the absorption in gases depends on the angle between the directions of propagation of light and sound. The relation between the intensity of the diffracted light and the angle mentioned is graphed. With the Bragg position of maximum intensity as zero, the graph shows two much smaller maxima on each side as the angle varies from 0·0° to ± 0·5°. The deformation of the waves is caused by currents set up in the medium by the vibrating quartz plate, and methods are described for overcoming this source of disturbance. To measure the absorption of the supersonic wave energy an optical arrangement is described for obtaining the intensity curve, integration over which gives the integration of the total sound energy. The diminution of this integral with increase of distance from the quartz plate gives the coefficient of absorption. [See following Abstract.] G. E. A.

1897. Theory of measurement of absorption of supersonics. E. David. *Phys. Zeits.*, **41**, *pp.* 37–41, *Jan.* 15, 1940.—A mathematical calculation to prove that the Petersen method [see preceding Abstract] leads to correct values of the coefficients of absorption of supersonic waves, irrespective of the structure of the sound field. G. E. A.

1898. Sound diffraction and absorption by a strip of absorbing material. J. R. Pellam. *Acoustical Soc. of America, J.*, **11**, *pp.* 396–400, *April*, 1940.—An exact solution for the sound energy absorbed by an absorbing panel set in the surface of a large, rigid, plane wall is obtained. The ability of the strip for absorbing sound is given by a " shape factor " *A*, defined as the ratio of the energy retained by the panel to the energy which would be absorbed, at normal incidence, by the same section of an infinite wall, covered uniformly with the same material. Curves of *A* are given for three angles of incidence, and for a wide range of wavelengths and of normal acoustic impedance of the absorbing material. The " shape factor " reveals that a given material composing a panel absorbs most efficiently when the panel-width approximates to, or slightly exceeds, $\lambda/2$ of the incident sound. For such widths, the factor is larger than 2 in the case of very " soft " materials, and reduces to unity for less and less absorbent panels. Author.

1899. Theory of fluctuations in decay of sound. R. C. Jones. *Acoustical Soc. of America, J.*, **11**, *p.* 485, *April*, 1940.—Corrections. [See Abstract 836 (1940).]

1900. Locus of distortion in the ear. E. G. Wever, C. W. Bray and M. Lawrence. *Acoustical Soc. of America, J.*, **11**, *pp.* 427–433, *April*, 1940.—An investigation was made of the locus of distortion in the ear by the surgical separation of middle and inner ear structures at the stapes. Stimulation of the isolated inner ear by mechanical vibrations gave a distortion pattern of the same type as that obtained from the intact ear by aerial stimulation. It is concluded that it has its seat of origin beyond the stapes, perhaps in the hair cells of the organ of Corti. Authors.

1901. The residue, a new component in subjective sound analysis. J. F. Schouten. *K. Ned. Akad. Wet., Proc.*, **43**, 3, *pp.* 356–365, 1940. *In English.*—Previous experiments with an optic siren giving sounds of any prescribed wave-form [see Abstract 1323 (1939)] have shown that non-linear distortion in the human ear is far less pronounced than is stated by some authors. Further experiments show that Ohm's law of subjective sound analysis may be extended as follows : (1) The ear analyses a complex sound into a number of components each of which is separately perceptible. (2) A number of these components correspond with the sinusoidal oscillations present in the inner ear sound field. These components have a pure tone quality. (3) One or more components may be perceived which do not correspond with any individual sinusoidal oscillation, but which are a collective manifestation of some of those oscillations which are imperceptible or barely perceptible individually. These components, which are termed residues, have an impure sharp tone quality. The loudness of the residue in a periodic impulse is greatly diminished if the higher harmonics are cut off, the residue being a collective manifestation of these higher harmonics. Experiment shows that the ear ascribes a pitch to a residue by virtue of the periodicity of the total wave-form of the harmonics which are responsible for this residue. The pitch ascribed to a complex sound is the pitch of that component to which the attention is most drawn, either by virtue of its loudness, or of its contrast with former sounds.

Repetition of some of Seebeck's experiments confirm his criticisms of Ohm's law and show that in complex sounds it is not the fundamental tone itself which is so much stronger than should be expected, but that an additional subjective component of almost identical pitch and often of great loudness is present in the sound. This hypothesis of the residue may be of importance in connection with the strike note of bells. This problem will be dealt with in a subsequent paper. A. W.

1902. Transmission of sound through single and double sheets of plate glass. L. Renault. *Rev. d'Acoustique*, **8**, *pp.* 12–46, *Jan.–June*, 1939.—The author calculates the attenuation of sound produced by glass sheets mechanically insulated, rigid, subjected to elastic constraint and presenting no internal absorbing surface. The attenuation is, for a single sheet, proportional to the logarithms of the surface density of the glass and the frequency of the sound. For a double sheet it is, in general, less for low frequencies and greater for high frequencies than the attenuation for the single sheet of the same mass. In the second part of the paper the results of much experimental work on several kinds of glass are given; these follow the theory more closely, the lighter the glass and the lower the frequency of the sound. G. E. A.

1903. Sound-absorbing properties of common outdoor materials. G. W. C. Kaye and E. J. Evans. *Phys. Soc., Proc.*, **52**, *pp.* 371–379, *May*, 1940.—The sound absorption coefficients of pure sounds of frequencies from 125 to 4 000 c./s. have been measured at random incidence for specimens of some commonly occurring outdoor materials, among them, gravel, turf, sand, ashes, railway-track ballast and snow. They mostly share the common characteristic of increased absorption with rising pitch. Some of the materials (e.g., loose grave soil and ashes) are highly absorbent, snow is remarkably so, while others (e.g., compressed gravel and wet sand) are indifferent absorbents. Some practical aspects are discussed, and also the influence of nearly grazing incidence, such as often obtains with outdoor sounds, in raising the degree of absorption. Authors.

See also Abstract 1710, and

1127B. Acoustic air-jet generator. J. Hartmann.
1128B. Sound radiometer of resonance type. T. Hayashi.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

See Abstract 1886, and

954B. Sensitivity of the 4-arm bridge. A. C. Seletzky and L. A. Zurcher.
961B. Bridges for measurement of capacitance and loss factor of insulated and earth test specimens. H. Poleck.

CONDUCTION AND DISCHARGE IN GASES.

1904. Residual currents in a.c. discharges. J. D. Cobine and H. Klemperer. *Frank. Inst., J.*, **229**, *pp.* 477–489, *April*, 1940.—A point by point determination is made of the residual current flowing during the reignition period of an a.c. arc between pure graphite electrodes in atmospheric air. The air pressure is varied from 0·14 to 5·4 atm. absolute and the gap varied from 1/4 to 5 mm. A.c. of 60 c/s. is supplied to the arc by a 10 kV power transformer and the r.m.s. discharge current is limited by ohmic resistance to values between 0·05 and 2 A. The residual current rises to a peak shortly after the voltage reverses and the current then *decreases* as the recovery voltage increases to its reignition value. The peak of the residual current increases directly with the r.m.s. current of the arc, and is essentially independent of both the length of the gap and the pressure of the gas. The reignition voltage is shown to be a function of the value of residual current existing just prior to ignition. The rate of decay of residual current decreases as gas pressure and gap length are increased. AUTHORS.

1905. Rôle of ionization by positive ions in spark breakdown. R. N. VARNEY, L. B. LOEB AND W. R. HASELTINE. *Phil. Mag.*, **29**, *pp.* 379–390, *April*, 1940.—The original Townsend theory of ionization by collision as applied to spark breakdown requires the assumption of ionization by collision with low-speed positive ions. In a recent paper Townsend has put forward evidence designed to prove the possibility of such ionization. The present work consists of a critical analysis of this evidence. It is shown that no such ionization has ever been observed at energies less than 3 times the ionization potential, and under most circumstances much greater energies are required. It is further shown that the second of Townsend's assumptions, that the ion free-path may be calculated by an extrapolation of viscosity theory to high temperatures, results in even more serious experimental disagreements. Both these factors militate against the occurrence of ionization by positive ions, and even on the basis of Townsend's theory, when the modern values of the constants are inserted, the equations lead to impossible probabilities of ionization. J. E. R.

1906. Recombination of small and large ions in gases at high pressures. W. R. HARPER. *Phil. Mag.*, **29**, *pp.* 434–448, *May*, 1940.—The recombination coefficient for both large and small ions at high pressures is derived by a rigorous treatment. For small ions the formula reduces to that of Langevin. It is shown how it was possible for Langevin to obtain the correct result without allowing for the effects of diffusion. The condition for the recombination coefficient to be independent of concentration is investigated, and it is found that for small ions the theory is not invalidated on this account unless concentrations are greatly in excess of those found in an α-particle track at 100 atm. AUTHOR.

1907. Excitation of atoms by electron collision. T. YAMANOUCHI AND M. KOTANI. *Phys. Math. Soc. Japan, Proc.*, **22**, *pp.* 14–33, *Jan.*, 1940.—The mysterious nebular and auroral lines are now identified with the emission lines due to forbidden transitions of atoms or molecules (including ions) from one of the metastable states to another or to the ground state, and some of the transition probabilities for these electric quadrupole and magnetic dipole radiations have been calculated. In this paper excitation of atoms by electron collision is considered, and the method for finding the probabilities of excitation of an atom by electron impact is described generally and applied to atoms in p^n-configurations. The probability is obtained by two quite different methods, viz., (1) Excitation considered as transition, whereby the general idea of transition probability between two quantum states is derived and the labour of calculation of matrix elements is largely reduced by group-theoretical consideration. (2) Determination of the approximate solution of the stationary state of the whole system (the atom and the free electron), a method which is capable of extension so as to include the effect of non-orthogonalities of wave functions. The present theory gives also the probability that the metastable states are destroyed by electron impact, and from the side of the colliding electron it is the theory of exchange scattering. H. H. Ho.

See also Abstract 1793, 1950.

CONDUCTION IN SOLIDS AND LIQUIDS.

1908. Theory of conductivity in metals. K. Ariyama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 949, *pp.* 1–9, *Jan.*, 1940. *In German.*—The paper represents a theoretical investigation considering the effect of certain approximations in the derivation of C, the constant of mutual relation between electrons and atomic oscillations in metals. Substituting into the wave equation of the electron the function of undisturbed atomic oscillation, it was suspected, might be responsible for the disagreement between theory and observation, which was experienced in many cases except Na and K. A better approximation is attempted by introducing an additional term of spherical symmetry into the undisturbed function. It can be derived by the Rayleigh-Schrödinger method. This is done under the assumption of non-atomic structure. Data for the actual evaluation were only available for Li. Following strictly Bloch-Bethe's theory of conductivity, a new constant C' is obtained for the case of high temperatures. The result, however, shows that there is practically no difference between the two constants. The same must be expected for all monatomic metals. H. O. S.

1909. Corpuscular theory of electrical conductivity of metals. T. V. Ionescu. *Comptes Rendus,* **210,** *pp.* 502–504, *April* 1, 1940.—Using the method [see Abstract 1647 (1940)] by which the diameter of the electron is considered as being inversely proportional to its velocity, the author develops a formula for the conductivity of metals. An expression is given for the frequency of vibration of the electrons and of the positive ions in the metal lattice. Calculated and observed values are given in tables in the cases of Cu, Al, Au and Na at various temperatures. The agreement is good. G. O. B.

1910. Electrical resistance of liquid sodium. A. Harasima. *Phys. Math. Soc. Japan, Proc.,* **22,** *pp.* 183–188, *Feb.*, 1940.—The absolute value of the electrical resistance of liquid Na is calculated on the basis of the electron theory of metallic conduction by using the model of Wall [see Abstract 515 (1939)] by which he calculated the atomic distribution function. The agreement between theoretical and experimental values is fairly good. Further, the temperature coefficient of resistance is calculated. Finally, values calculated by using the present writer's model are given. Author.

See also Abstracts 1855, 1916, 1951, and

957B. Moving-iron instruments for accurate measurement. H. Toeller.
959B. Conductivity-meter for frequencies from 0·1 to 1 000 Mc./s. G. Opitz.
997B. Automatic voltage regulator without moving parts employing ferro-resonance. P. H. Craig.
998B. Stabilizing arrangements with automatic voltage regulators. A. Lang.

DIELECTRICS AND CAPACITANCE.

1911. Ionic character and dipole moments. F. T. Wall. *Am. Chem. Soc., J.,* **62,** *pp.* 800–803, *April,* 1940.—A theory of dipole moments of diatomic molecules is developed and it is shown that the sum of the

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dipole moments of two states resulting from resonance is the same as the sum of the dipole moments of the original states. Assuming a wave function $\psi = \psi_c + a\psi_i$ for a system resonating between covalent and ionic states, upper and lower limits to $|a|$ are calculated using dipole moment data, and the results compared with calculations of $|a|$ based on energy values. AUTHOR.

1912. Dipole moment, induction and resonance in tetra-, penta- and hexa-substituted benzenes. C. P. SMYTH AND G. L. LEWIS. *Am. Chem. Soc., J.*, **62**, *pp.* 721–727, *April*, 1940.—The dipole moments of 14 tetra-, penta-, and hexa-substituted benzenes with Cl and CH_3 and NO_2 groups as substituents have been measured in dilute solutions in benzene. The values are compared with those calculated as the vector sums of the moments of mono-substituted benzenes and the effect of induction between groups is taken care of by using the moment of a di-, tri-, or tetra-substituted molecule as a single vector. On the whole, satisfactory agreement is obtained between the observed and the calculated results. The alteration in the moment due to one group produced by the resonance effects of another group is evident in *p*-chloronitrobenzene, but is too small to detect with certainty in these results where CH_3 and CH_3, CH_3 and Cl, or Cl and Cl are the groups involved, although an indication of a possible small increase in moment due to such effects is given. AUTHORS.

1913. Behaviour of polar molecules in solid paraffin wax. D. R. PELMORE AND E. L. SIMONS. *Roy. Soc., Proc. A.*, **174**, *pp.* 253–254, *April* 10, 1940.—The work of Sillars [see Abstract 403 (1939)] on long-chain esters, containing an even number of C atoms, embedded in a paraffin wax medium, has been extended to esters with an odd number of C atoms. Measurements of the dielectric properties of amyl stearate, containing 23 C atoms, show that there is little difference between the behaviour of the odd ester and its two even neighbours. E. R.

***1914. Residual active layer in electrolytic condensers.** A. MIYATA. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 952, *pp.* 30–57, *Jan.*, 1940.—The residual active layer is that part of the innermost surface of the thick oxide film formed by anodizing an Al plate, and experiment shows that it persists indefinitely after the treatment, and it is this which enables the large capacitances of electrolytic condensers to be obtained. The wetted oxide film acts as if it had a large capacitance in series with a resistance. The dielectric constant of the dry Al_2O_3 film is about 8. About 75–80% of the original active layer is retained in the d.c. film, but about 30% in the a.c. film, the latter having an irregular surface, and being greatly affected by heat. The residual active layer is dissolved by K_2CO_3, Na_2CO_3, and KNO_3, etc., particularly when it is cathodic. Electrolytes which are suitable for the formation of an anodic film ($H_2C_2O_4$, H_2SO_4) also attack the active layer when it is cathodic, and such reagents may be utilized to increase the porosity of the film. [See following Abstract.] A. M. T.

***1915. Effect of Al_2O_3 film upon formation of active layer in electrolytic condensers.** A. MIYATA. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 956, *pp.* 85–113, *Feb.*, 1940.—This report deals with the effect of the existence of the thick and porous oxide film upon the formation of the active layer, when Al is anodically treated previously in aqueous solution of oxalic acid, and studies the relation between the conditions in the preparation of the porous film, the voltage rise and the puncture voltage in the formation at constant current density. [See preceding Abstract.] AUTHOR.

1916. Physics and electrical insulation. A. M. THOMAS AND S. WHITEHEAD. *Journ. Sci. Instruments*, **17**, *pp.* 77–83, *April*, 1940.—The fundamental physical nature of the phenomena associated with electrical insulating material is discussed. Gaseous, liquid and solid dielectrics are first separately considered from the standpoint of their electric strength and conductivity, then follows a brief review of present day conceptions of dielectric losses and permittivity (dielectric constant) and finally an indication of the lines which physical research is now following. A Bibliography of recent papers bearing on the various aspects of the subject is included. A. M. T.

See also Abstracts 1825, 1855.

ELECTROCHEMISTRY.

1917. Thermodynamic properties of H_2SO_4 solutions and their relation to the e.m.f. and heat of reaction of lead storage battery. D. N. CRAIG AND G. W. VINAL. *Bureau of Standards, J. of Research*, **24**, *pp.* 475–490, *April*, 1940.—The heat of reaction in a lead storage cell involves reactions at the positive and negative plates and changes in the heat content of H_2SO_4 solutions. The latter is a variable factor, depending on the concentration of the solution. Newly computed values of the partial molal heat contents have made possible more accurate values of the heat of reaction, based on thermochemical data for comparison with similar values computed from the best available electrochemical data. Good agreement was found. The partial molal heat capacity of H_2SO_4 solutions has also been recalculated. Critically selected values of e.m.f. and temperature coefficient are given. These include previously unpublished values obtained at this Bureau in 1933. The partial molal volumes of H_2SO_4 solutions are given for a few concentrations and these are used for computing changes in e.m.f. with change in pressure. AUTHORS.

1918. Ionization constants of weak acids from conductance measurements. Method of extrapolating data. B. SAXTON AND L. S. DARKEN. *Am. Chem. Soc., J.*, **62**, *pp.* 846–852, *April*, 1940.—A method of extrapolating ionization constants determined by the conductance method has been suggested. The method consists of plotting the logarithm of the ionization constant, which includes the ion activity coefficient calculated by the Debye-Hückel limiting law, against the concentration of undissociated electrolyte. The validity of the method is based mainly on empirical evidence which indicates the linearity of such a plot up to high concentrations in the case of the organic acids considered. The thermodynamic ionization constants of cyanoacetic, formic, and butyric acids in aqueous solution at 25° have been measured by the conductance method and found to be: cyanoacetic acid $3\cdot360 \times 10^{-3}$; formic acid $1\cdot825 \times 10^{-4}$; butyric acid $1\cdot518 \times 10^{-5}$. AUTHORS.

1919. Errors in determination of dissociation constant of weak acid by extrapolation method. M. L. KILPATRICK. *J. Chem. Phys.*, **8**, *pp.* 306–313, *April*, 1940.—In the extrapolation method for determining the dissociation constant of a weak acid the value of the limiting equivalent conductance is not known from independent measurements, and both the limiting equivalent conductance Λ_0 and the dissociation constant K are obtained from conductimetric measurements on solutions of the acid. While clearly convenient, the reliability of the method has been questioned.

In the present paper equations are derived which express the effect on K and on Λ_0 of errors in the experimental quantities. For water as solvent, tables are given showing the numerical values of the errors. The possibility of detecting constant errors is discussed. AUTHOR.

1920. Translucent Al_2O_3 films. R. E. VOLLRATH. *J. Phys. Chem.*, **44,** *pp.* 401–404, *April*, 1940.—A method for the production of translucent Al_2O_3 films was developed. Al foil 0·002 cm. thick was allowed to dip just into a 3% solution of oxalic acid contained in a litre battery jar. The foil was made the anode of the electric circuit, the cathode being a carbon rod. A current of 30 mA at 120 V was allowed to pass. As the Al is converted into the oxide, oxalic acid of the same concentration is allowed to flow into the electrolytic cell from a reservoir, the current being regulated to maintain a current density of about 2 mA/cm^2. The foil can be oxidized in this way at the rate of about 2 cm./hr. The films so prepared showed a considerable degree of flexibility, and a transparency resembling that of thin tissue paper or tracing paper. F. J. B.

1921. Hg_2Br_2 electrode. W. D. LARSON. *Am. Chem. Soc., J.* **62,** *pp.* 764–765, *April*, 1940.—The standard potential of the Hg-Hg_2Br_2 electrode, determined by measurements of the cell Ag/AgBr, KBr, Hg_2-Br_2/Hg, is 0·1397 V at 25°. From temperature-coefficient measurements the standard entropy of Hg_2Br_2 was computed. The standard entropy of solid Hg_2Br_2 computed was 48·7 cal. deg.$^{-1}$ mole^{-1}. AUTHOR.

See also Abstracts 1804, 1880, 1914 and 1915.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

1922. Scattering of neutrons. S. KIKUCHI AND T. WAKATUKI. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 142–144, *Feb.*, 1940.—Previous work [see Abstract 884 (1940)] on the angular distribution of neutrons scattered by atoms and found to be by no means spherically symmetrical, but with the probability of much greater scattering for small angles than for large angles, is now reviewed. It is found that the predominance of small-angle scattering increases regularly with increasing atomic number both for D-D and Li-D neutrons and seems to indicate a general disposition independent of the energy of the neutrons. The facts are explained by introducing a "nuclear form factor," similar to the case of X-rays, in which predominance of small-angle scattering over the Thomson factor was explained by introducing "atomic form factor". The total scattering cross-section, however, is not a monotonic function of the atomic number, while the distribution curve has a maximum at the scattering angle of about 20°. H. H. Ho.

1923. Spin-orbit interaction between elementary particles and angular asymmetry in neutron-proton scattering. T. MIYAZIMA. *Phys. Math. Soc. Japan, Proc.*, **22,** *pp.* 188–197, *Feb.*, 1940.—The ground state of the deuteron is considered as a mixture of ^3S and ^3D and the problem takes the form of simultaneous equations between ^3S and ^3D. The form of potential used by Flügge is adopted [see Abstract 579 (1940)], and the experiments on the quadrupole moment and binding energy of the deuteron and the total cross-section for thermal neutrons have been invoked to assist in fixing the values of the constants involved. The results indicate a contribution of ^3D to an extent of about 20% in the ground state, but this has little effect on the scattering of fast neutrons by protons and still leaves unexplained the large angular asymmetry. W. E. D.

1924. Interaction between neutrons and matter. Part II. F. A. Heijn. *Ned. T. Natuurk*, **7,** *pp.* 107–123, *Feb.*, 1940.—In continuation of an earlier report [see Abstract 2625 (1939)] the action of slow neutrons is now dealt with. R. P.

1925. Anomalous scattering of fast neutrons. M. R. MacPhail. *Phys. Rev.*, **57,** *pp.* 669–676, *April* 15, 1940.—The cross-sections of a number of elements for neutron scattering were measured as a function of neutron energy through a range of 0·5 eMV. Anomalous cross-sections were found in the cases of Mg and Al. It was possible to account quantitatively for the anomaly in Mg on the assumption that the effect was due to resonance in Mg^{25}. Author.

1926. Dynamical theory of electron diffraction. C. H. MacGillavry. *Physica*, **7,** *pp.* 329–343, *April*, 1940. *In German.*—This paper contains a development of Bethe's dynamical theory of electron diffraction in thin crystals, taking into account the interaction between the dipoles of the medium and the scattered beam as well as with the primary beam, and therefore applicable even when the kinematical theory breaks down. The variation of the intensity of the scattered beam is investigated on the lines of the electron diagram of Kossel and Möllenstedt. The absolute value of the structure factor is obtained entirely from *geometrical* measurements of the fine structure minima, no intensity measurements being necessary. The present theory gives numerical results in excellent agreement with those obtained from experiment. Unfortunately it is useful only for accurately plane parallel crystal sheets, so that it can be applied only to crystals showing good cleavage. E. E. W.

1927. Secondary emission from films of Ag on Pt. A. E. Hastings. *Phys. Rev.*, **57,** *pp.* 695–699, *April* 15, 1940.—Total secondary emission and energy distribution of secondary electrons have been measured for films of known thickness of Ag on Pt. The depth of origin of the total secondary emission in Ag as a function of primary energy, and the depth of origin of secondaries having a given energy were determined. Practically all the secondaries from primaries of 20 eV energy originate at a depth of less than 15 atomic layers, and those from primaries of 50 eV energy originate at a depth of less than 30 atomic layers. For higher primary energies, it was found that an appreciable amount of emission comes from a depth greater than 150 atomic layers. Secondaries with energies close to that of the primaries originate at a depth small compared with that of the low energy secondaries. Author.

1928. Visibility of bacteriophage cultures in the ultramicroscope. H. Ruska. *Naturwiss.*, **28,** *pp.* 45–46, *Jan.* 19, 1940.—Photomicrographs are reproduced of various bacterial cultures examined by the electron microscope using a magnification of 14 000 : 1. F. C. C.

1929. Ultramicroscopic examination of bacteriophages. E. Pfankuch and G. A. Kausche. *Naturwiss*, **28,** *p.* 46, *Jan.* 19, 1940.—Photomicrographs with the electron camera show that certain bacteriophages are destroyed by long exposure and that their apparent structure, as shown by the photographs, depends on the conditions of photography as well as on the intrinsic properties of the culture. F. C. C.

***1930. Apparatus for boring extremely fine holes in metal foil.** M. v. Ardenne and H. Reibedanz. *Zeits. f. Instrumentenk.*, **60,** *pp.* 22–26, *Jan.*, 1940.—The apparatus is designed to bore circular holes of 10 μ or less at the centre of circular sheets of thin metal foil. In principle, a sewing needle (No. 7–10) is mounted in an adjustable support so that the needle point presses on the centre of a firmly clamped metal foil disc. Boring is performed by hand by slowly rotating the needle and the process is followed with the aid of a microscope, which also serves to obtain accurate centreing of the needle point on the foil. Photographs of 10 μ and 15 μ diameter holes are given in illustration. [See Abstract 4149 (1939).] H. J. H. S.

***1931. Types of electron microscope.** H. B. DORGELO. *Ned. T. Natuurk.*, **7**, *pp.* 157–170, *April*, 1940.—The general principles of electron microscopes are reviewed, the three main kinds, "shadow," magnetic- and electric-focusing types being considered. The resolving power is discussed, and it is shown that in practice it cannot be made much more than 100 times that of the best optical microscope, since although very short wavelength is used, the aperture has also to be small to avoid optical defects such as aberration, astigmatism, etc. D. S.

1932. Theoretical foundations of electron optics. R. KRONIG. *Ned. T. Natuurk.*, **7**, *pp.* 171–178, *April*, 1940.—A brief review is given of the principles of electron optics, including a discussion of the faults of electronic lenses and their resolving powers. The analogies with ordinary optics are emphasized. D. S.

***1933. Supermicroscopy.** H. RUSKA. *Ned. T. Natuurk.*, **7**, *pp.* 179–191, *April*, 1940.—A review is given of the practical applications of electron microscopy, particular mention being made of the technique of preparing suitable specimens of various organic materials for magnification of order 10^4 times. The article is illustrated by many photographs of magnified biological specimens. D. S.

See also Abstracts 1689, 1789, 1799, 1855, 1856, 1857, 1940, 1958, and

917B. Investigation of rapidly changing stresses with the cathode-ray oscillograph. S. L. de Bruin.

ELECTROSTATICS.

***1934. Pauthenier generator.** B. B. BHOWMIK. *Science and Culture*, **5**, *pp.* 535–540, *March*, 1940.—A description of the Pauthenier generator in which a circulating current of air at high pressure carries a blast of powdered glass. The blast passes close to a filament which acts as ionizer and the glass dust, so charged, conveys its charge to a metal collector over which the circulating current of glass and air pass. With an air current of 50 m./sec. the limit to the voltage obtainable depends entirely on brush discharge from the collector. The generator has undergone steady improvement and in the latest Paris model a current of 2 mA is obtained at a potential of 2·5 MV. F. C. C.

See also Abstracts 1914, 1915.

MAGNETISM AND ELECTROMAGNETISM.

1935. Ferromagnetic anisotropy, magnetization at saturation, and superstructure in Ni_3Fe and nearby compositions. E. M. GRABBE. *Phys. Rev.*, **57**, *pp.* 728–734, *April* 15, 1940.—The order-disorder transformation involving Ni_3Fe affects both the ferromagnetic anisotropy and the saturation magnetization. Fe-Ni alloys in the range 65 to 80% Ni have been investigated, using spheroidal specimens. With superlattice formation the anisotropy becomes more like that of pure Ni with (111) as the direction of easiest magnetization. The change is largest near Ni_3Fe. The saturation magnetization increases with ordering; the greatest observed increase was 5·8% for an alloy very near Ni_3Fe. Different rates of cooling from above the critical temperatures (about 490°C.) affect the saturation magnetization. These changes are attributed to changes in degree of local ordering effects. Long distance order, induced by baking for long periods, greatly influences both anisotropy and magnetization at saturation.

AUTHOR.

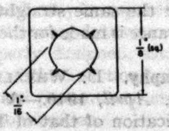
1936. Permalloy problem. H. SCHLECHTWEG. *Phys. Zeits.*, **41,** *pp.* 42–43, *Jan.* 15, 1940.—The Fe-Ni alloy which contains 78·5% Ni has a very high permeability after rapid cooling from 600°C. After slow cooling its permeability is much reduced and the slowly cooled alloy has an orderly arrangement of its atoms. On the basis of a recent research [see Abstract 4404 (1939)] the author considers that the higher permeability in the non-orderly condition may arise because a Barkhausen layer might be more easily displaced in the case of assemblages of ferromagnetic atoms of the same kind than it would in a region where the atoms are in orderly arrangement. G. E. A.

***1937. Iron-cored coils of high efficiency.** G. F. PARTRIDGE. *Phil. Mag.*, **29,** *pp.* 485–494, *May*, 1940.—The efficiency of laminated iron-cored coils as represented by their $L\omega/R$ value is considered. It is shown that, in order to take advantage of the low losses obtained with permalloy cores, it is necessary to use an air-gap. For any given frequency there is an "optimum gap" which gives maximum efficiency. Formulae are given for calculating the value of this gap, and also the efficiency of any given coil. Following from this it is shown that the frequency characteristic of such a coil will depend upon the value of the gap, in that it will be determined by the frequency for which the gap has been adjusted for the optimum condition. Theoretical curves are given and measurements confirming the results for frequencies up to 2 000 p.p.s. It is shown that the same principle accounts for the high efficiencies obtained by using composite cores such as Ferrocart and Gecalloy. AUTHOR.

1938. Change of torsion modulus of ferromagnetic substances with temperature and with magnetization. T. HIBI. *Tohoku Univ., Sci. Reports*, **28,** *pp.* 435–449, *March*, 1940.—The changes of torsion modulus of wire of Ni, Fe-Ni alloy ((Fe 65%–Ni 35%), and Ni-Cu alloy (Ni 75%–Cu 25%) with the temperature, and with the magnetization were measured by the quasi-statical method. The results in Ni were satisfactorily in agreement with those of Möbius [see Abstract 5257 (1934)]. In two other alloys here tested, the dependence of the modulus on the rise of temperature and on the magnetization was thoroughly observed. A qualitative interpretation of the results in the light of the domain theory of ferromagnetics is discussed. [See following Abstract.] AUTHOR.

1939. Change of damping coefficient of ferromagnetic substances due to magnetization. T. HIBI. *Tohoku. Univ., Sci. Reports*, **28,** *pp.* 450–457, *March*, 1940.—In this experiment the variation of the torsional decrement of the oscillations of ferromagnetic wires in a magnetic field are measured. The specimens used were the same as those in the previous experiment [see preceding Abstract]. The main results obtained are (1) the damping coefficient in a magnetic field of a constant intensity depends on amplitude, and it seems that there are two or three ranges of amplitude in which the damping coefficient is of a nearly constant value; (2) the maximum value of the damping coefficient, the field intensity from which this maximum value results, and the difference between the maximum value and the value when no field is applied, are in the same order of magnitude as in the corresponding ones observed in the change of the rigidity modulus. Some qualitative considerations on the interpretations of the results are discussed. AUTHOR.

***1940. Design for electromagnet and performance of small model.** S. FREED. *Rev. Sci. Instruments,* **11,** *pp.* 117–119, *April,* 1940.—The windings of the magnet are made of continuous lengths of copper tubing with cross-section shown in the accompanying figure. Water at high pressure is sent through the hollow centre for cooling. The conductor is wound about the core in such a way that the resistance to the flow of the water is reduced to about half what would prevail in a magnet of conventional design. These features make possible a high effective current density. The disposition of the coils and the shape of the iron core were based on the experiences with the big magnets in Upsala and in Paris. Results given by a model are indicated graphically. When the pole faces 2·5 cm. in dia. were separated by 7 mm. the field obtained was 33 200 gauss using 16 kW. The model was constructed to employ water at considerably higher pressures than were actually tried. A higher current density would then be permitted without risk of serious electrolytic corrosion. AUTHOR.



See also Abstracts 1708, 1727, and
984B. Magnetism and spin. E. Brylinski.

MEDICAL RADIOLOGY AND ELECTROLOGY.

1941. Biological effect of magnetic fields. M. LENZI. *Ricerca Scientifica,* **11,** *pp.* 166–174, *March,* 1940.—This paper describes the result of researches on the biological effect of magnetic fields—both alternating and continuous. The investigations cover particularly experiments in the cultivation of cells *in vitro,* on the processes of repair of wounds in the skin and in bones, and on the flourishing and development of glandular carcinoma of Ehrlich in white mice. G. G.

***1942. Recording system designed for investigation of electrical relations in brains of small animals.** G. A. WOONTON. *Canad. J. of Research, A,* **18,** *pp.* 65–73, *April,* 1940.—A two-channel recording system, designed for the investigation of brain potential variations in several parts of the brain simultaneously, is described in detail. The oscillographs are of the cathode-ray type; each is driven by a voltage amplifier employing standard radio tubes. Complete shielding of the amplifier components and the use of symmetrical circuits have been found sufficient to eliminate electrical interference. The system is free from phase and frequency distortion between 10 and 800 c./s. and is not seriously affected by either form of distortion between 5 and 1 500 c./s. The author believes that this covers the important frequency range for this type of investigation.
AUTHOR.

***1943. Radiographic mensuration and localization.** J. P. Hederman. *Brit. J. of Radiology,* **13,** *pp.* 123–126, *April,* 1940.—The author describes an instrument designed for radiographic pelvimetry consisting of a special type of caliper having three arms, two long ones and a short one with a slot. One long arm and the short arm can be locked together or they can move independently. To measure the antero-posterior and transverse diameters of the pelvic brim, the caliper is applied to anatomical landmarks on the patient and radiographs are taken which show the images of both points of the caliper. The diameters are obtained after a simple correction for radiographic magnification. For the localization of foreign bodies, the patient is screened antero-posteriorly and the skin is marked over the foreign body at front and back. The caliper is applied to these points and a lateral radiograph is taken which will show the points of the caliper and the foreign body all in the same straight line. The exact position can be calculated after allowance is made for the radiographic magnification on the film. T. A. C.

***1944. Simplified planigraphy.** D. Wheeler and E. W. Spencer. *Radiology,* **34,** *pp.* 499–502, *April,* 1940.—A description is given of an apparatus which is a modification of that of Twining [see Abstract 2829 (1937)] which consists of an attachment to a Potter-Bucky table, by means of which a selected plane or stratum of a patient's body can be shown on a radiograph. A historical review is given of the subject of planigraphy and some of the commercial apparatus developed for the work is stated to have the disadvantages of excessive cost, excessive floor space and complex operation. It is claimed that the present apparatus can be made by any machinist and fitted to the standard Bucky table in less than 5 min. A mathematical proof of its system of operation is given and the apparatus is stated to fulfil the 6 requirements of Grossman for successful planigraphy: (1) The effective blurring of large disturbing shadows proximal to the layer to be radiographed; (2) shortness of exposure; (3) provision for examining large areas, such as the thorax; (4) obtaining sharp outline; (5) variability of the focus-body layer apparatus, and (6) simplicity of the apparatus and its operation. T. A. C.

1945. Bactericidal irradiation of air. Part I. Physical factors. W. F. Wells. *Frank. Inst., J.,* **229,** *pp.* 347–372, *March,* 1940.—Most previous studies of lethal radiation have been concerned with cases in which bacteria are exposed on fixed surfaces equidistant from the source or in small volumes. In the present work the problem investigated is that of the disinfection of a large volume of moving air by means of a single u.v. light source. The first part of the paper consists of a mathematical analysis of the relationship between lethal action and intensity, time and distance. The cases considered are (*a*) infinite mixing of the air, (*b*) zero mixing, (*c*) uniform linear air flow approaching the light, (*d*) uniform linear flow passing the light, (*e*) stream line cylindrical flow and (*f*) turbulent cylindrical flow. Experiments have been carried out in an air tunnel to test the validity of the relationships. The experimental results confirm essentially the basic assumptions of the theories put forward. The most striking effect observed was that of humidity on the lethal effectiveness of the radiation. In one case there was a ten-fold difference in killing power of the same light corresponding to a change in relative humidity from 46% to 91%. A convenient system of units of lethal irradiation is suggested. The basis of this is the unit of lethal exposure, the *lethe,* which is defined as the uniform exposure from which e^{-1}, or 36·8% of the standard organisms (*Esch.-coli*) survive. Other terms thus defined are lethal intensity, lethal radiation, lethal power, lethal irradiation and coefficient of utilization. A short discussion of the dependence of bactericidal action on radiation quality, and of the quantum theory of lethal action follows. J. E. R.

1946. Protection of the X-ray worker. G. W. C. Kaye. *Radiography*, **6**, *pp.* 41–59, *March*, 1940. *Nature*, **145**, *pp.* 370–373, *March* 9, 1940.—This paper, starting with an historical introduction, and leading to the establishment of the British X-ray and Radium Protection Committee and later the International X-ray and Radium Protection Commission, discusses the various aspects of the protection of X-ray and radium workers. It is pointed out that as regards protection from the action of the radiation itself, the essential basis is the accepted tolerance dosage rate of 1/1 000 erythema dose in 3 days, which may be regarded as equivalent to 1 röntgen per week. On this basis, and having data concerning absorption, protective arrangements may be properly designed, and their efficiency tested by several different methods. Other sections deal with the necessity for adequate ventilation, electrical precautions, etc., while the basic principles of neutron protection are touched on. G. E. B.

1947. Economic features of X-ray protection. L. S. Taylor. *Radiology*, **34**, *pp.* 425–437, *April*, 1940.—Regulations and recommendations on permanent X-ray protection give maximum protection. In certain cases it is possible to reduce the amount of protective material and yet retain adequate safety. As such X-ray protection may be an expensive item the subject is one of economics. Lead is commonly used and considerations are given to show that if all the relevant factors are taken into account considerable economies are possible. Concrete is sometimes to be preferred, and above 200 kV it has advantages over lead, especially where a concrete wall forms part of the structure of the building. Experimental work is detailed and data given. Costs are compared, for various cases, and tables and curves given. Secondary radiation due to scattering is also considered. E. H. W. B.

1948. Variation with wavelength of biological effect of radiation. I. Lasnitzki and D. E. Lea. *Brit. J. of Radiology*, **13**, *pp.* 149–162, *May*, 1940.—Experiments are described in which the inhibition of mitosis in tissue cultures by doses of X-rays and γ-rays of the order of 20–200 röntgens is measured and used as a means of comparing the relative effectiveness of X-rays and γ-rays. X-rays of effective wavelength 0·107, 0·150 and 0·363 Å are found not to be significantly different in the effect they produce per röntgen, but γ-rays are markedly less effective, by a factor of about 2 to 1. The result is shown to be a real difference and not an accidental one due to a lack of proportionality between ionization in tissue and ionization in air. By incorporating the results of other workers on the effects of heavily filtered γ-rays and neutrons respectively on tissue cultures, it is possible to draw a curve of relative effectiveness of radiation against quality of radiation. X-rays and neutrons appear to be equally effective, but γ-rays are less effective than X-rays, and become progressively less effective with diminishing wavelength. Authors.

1949. Biological effects of nuclear disintegration products on neoplastic tissue. P. G. Kruger. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 181–192, *March*, 1940.—An experimental determination of the effects of the disintegration products of ${}_5\mathrm{B}^{10} + n_0^1 \rightarrow {}_3\mathrm{Li}^7 + {}_2\mathrm{He}^4$ on neoplastic tissue when irradiated *in vitro* by slow neutrons with the biological test specimens immersed in a solution made by adding 2 gm. H_3BO_3 to 100 cm^3. of buffer solution. The capture cross-section for slow neutrons by B is about 100 times larger than the collision cross-section for fast neutrons and H, moreover the disintegration products $_3Li^7$ and $_2He^4$ of slow neutron boron reaction have 0·8 and 1·4 eMV energy [see Abstract 2390 (1938)]. These energies are dissipated in 4 and 7 μ distance in tissue and cause an even more intense ionization than the recoil proton in the fast neutron process. No element having an appreciable concentration in tissue, has a slow neutron capture comparable to boron and thus it is expected that no ill effects due to slow neutrons would occur elsewhere in the body. Consequently one can irradiate with large slow neutron doses provided care is taken to keep the background of fast neutrons and γ-rays below the lethal amount. Fast neutrons were produced by bombarding Be with 16 eMV deuterons in the 60 in. cyclotron of the Crocker radiation laboratory. These were slowed down in a paraffin-block 10-in. cube and the slow neutron dose was measured by the activity induced in an Au foil while the fast neutron-γ-ray background was measured with a victoreen dosemeter. The biological test specimens consisting of animal tumours were contained in test tubes in the paraffin block while control experiments were conducted simultaneously. After irradiation, the tumour particles were implanted in mice and the number of takes was observed. Graphs and tables are given summarizing the data on the irradiation of sarcoma, mammary carcinoma and lymphoma, by the disintegration products of the boron process and also by fast neutrons and X-rays. These graphs show that the dose necessary to obtain the same lethal effect with fast neutrons must be 4–5 times greater than that using the boron effect with the slow neutrons. It is emphasized however that this factor depends on the amount of B which can be introduced into the tumour and is meaningless except for the fact that it shows that a sufficient amount of boron can be dispersed through the tissues to accomplish the desired lethal effect. The author considers the results of these experiments *in vitro* indicate that neoplastic cells can be destroyed *in vivo* if sufficient B in some suitable form could be applied *in vivo*. T. A. C.

***1950. Neutron generator for biological research.** L. H. GRAY, J. READ AND J. G. WYATT. *Brit. J. of Radiology*, **13**, *pp*. 82–94, *March*, 1940.—This paper describes in considerable detail the construction of the two essential parts of a neutron generator of the deuteron-deuteron type, namely the h.t. generator giving 400 kV, and the neutron tube. The generator is of the Cockcroft type, employing demountable rectifiers. In the neutron tube, which also is demountable, the ions are produced by a hydrogen arc using D_2 prepared by electrolysis. Details of anti-corona shields and protective devices are given. G. E. B.

See also Abstract 1764, and

1020B. X-ray photographs with extremely short exposure times. W. J. Oosterkamp.

OSCILLATIONS AND WAVES.

***1951. High-gain linear amplifier employing degeneration.** A. A. PETRAUSKAS AND L. C. VAN ATTA. *Rev. Sci. Instruments*, **11**, *pp*. 103–104, *March*, 1940.—The paper discusses the performance of an amplifier, especially designed for nuclear detection work. It supplements Waddel's description of a similar circuit [see Abstract 4700 (1939)], with regard to its use for general purposes. A flat gain/frequency characteristic was

V.
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achieved by degeneration in the form of reverse feedback to self-biasing resistors. On account of the need for high initial amplication a 4-stage circuit was chosen. The method had to be adapted to this case. This was accomplished by dividing the circuit in two 2-stage units. Adequate dimensioning effected gain reduction at a rate of 5 000/500 in each unit, the overall voltage gain being 250 000. As a result distortion was reduced to 1/100. The time constant was chosen as 0·001, the total noise level measured amounted to between 2 and 3·5 V. Used in connection with Geiger counters and similar devices the apparatus worked satisfactorily.
H. O. S.

1952. Diffraction of radio ranges by hills. W. R. HASELTINE. *Phys. Rev.*, **57,** *pp.* 717–721, *April* 15, 1940.—The scattering of electromagnetic waves by hemispherical obstacles on a conducting plane has been investigated. The results have been applied to the problem of the splitting of radio range beacons when the range passes over hilly country. The calculations refer particularly to long wavelengths (about 1 000 m.) such as used in the Oakland range. It is found that even hills of moderate size can cause wide spatial fluctuations in the received signal strength. The results of numerical calculation for one simple model of the terrain are reported. The beam is found to split into several parallel courses, giving a pattern of the same type as is observed in the field. It is concluded that this phenomenon is a typical diffraction effect. AUTHOR.

1953. Aurorae, radio field-strengths and recent solar activity. H. T. STETSON. *Terr. Mag.*, **45,** *pp.* 77–86, *March*, 1940.—Recent discussion of the relation between aurorae and sunspots allows the possibility of corpuscular radiation taking about a day to travel from the sun to the earth. A summary of data going back to 1749 shows a lag of some two years between sunspot maximum and maximum auroral activity. A diagram of the Zürich sunspot numbers for the period from 5 days before to 5 days after bright aurorae recorded at Blue Hill, Mass., reveals a lag of one day between sunspot and auroral maxima. Combining these data with radio field-strength measurements made at Boston, from signals received from WBBM, Chicago, on 770 kc./s., it appears that minimum field intensities are received from one to two days after the occurrence of aurorae; and in this case, reflection from the E-layer of the ionosphere is involved. The effect on F-layer reflection is shown by data from the Bell Telephone Laboratories on trans-Atlantic transmission at 9 to 16 Mc./s., and there appears to be a lag of about half a day behind the aurorae. There is evidence also that the ionization giving rise to magnetic disturbances either slightly precedes, or is concomitant with the radio modification of the F-layer. A sequence of events in the order solar activity, aurorae, F-layer ionization, E-layer ionization, is therefore established. J. P. A.

1954. Propagation of electromagnetic waves in an atmosphere containing free electrons. L. G. H. HUXLEY. *Phil. Mag.*, **29,** *pp.* 313–329, *April*, 1940.—The general equations for a plane electromagnetic wave are developed, and a concise summary of the usual development of magneto-ionic theory given. As this theory has the weakness of being based on the motion of a single ion, a new approach is then made, starting from the equations for the conductivity of a gas containing free electrons. The general equations for the propagation of plane electromagnetic waves in such a gas are developed, and it is shown that they reduce to the same forms as in the older theory, in a region (such as the F-region of the ionosphere) where collision frequency is very small; and although in other cases the equations differ in form on the new theory, deductions made from them do not seriously differ from the results of the older ionospheric theory, except at frequencies near the gyro-frequency. The new theory is not yet fully elaborated. J. P. A.

See also Abstract

1088B. Rôle of ionosphere in radio wave propagation. J. H. Dellinger.

PHOTO-ELECTRICITY.

***1955. HgO as a photocell.** G. DÉCHÊNE. *J. de Physique et le Radium*, **1**, *pp*. 112–120, *March*, 1940.—The photocell of a new type which is described consists of a quantity of HgO contained between two electrodes, one of which is transparent being made of cellophane made conducting by immersion in H_2SO_4. The HgO is found to have a high resistance at the surface of contact with the transparent electrode. This resistance decreases considerably on exposure to visible or u.v. radiation, but little on exposure to infra-red radiation. This property allows the apparatus to be used as a photocell. Various properties of the cell have been investigated and its behaviour indicated when the light flux, cell potential, etc., are varied. A theoretical discussion is given. The phenomena are attributed to a secondary photoconductivity effect in a thin layer of HgO in contact with the electrode. Some possible applications of this form of cell are indicated. G. O. B.

See also Abstracts 1811, 1812.

THERMIONICS.

1956. Experimental determination of electron affinity of chlorine. J. J. MITCHELL AND J. E. MAYER. *J. Chem. Phys.*, **8**, *pp*. 282–285, *March*, 1940.—The electron affinity of chlorine has been determined to be about 92·7 kg.cal. by measuring the ratio of ions to electrons and atoms leaving a hot W surface. Owing to the reactivity of the chlorine a certain erratic behaviour leads to some possible scepticism as to the accuracy of the result. [See Abstract 929 (1935).] AUTHORS.

***1957. High-efficiency ion source.** A. T. FINKELSTEIN. *Rev. Sci. Instruments*, **11**, *pp*. 94–97, *March*, 1940.—An ion source has been built in which the ionization efficiency of the electrons is increased without making the gas pressure excessive. This is accomplished by making the electrons oscillate through the region occupied by the gas with energies corresponding to the maximum ionization probability. The electronic space charge is used to withdraw the ion beam and hold the beam together. H-ion beams of 150 mA have been obtained. AUTHOR.

1958. Attempt to neutralize space-charge of hot filament by fast positive Hg ions. R. M. CHAUDHRI, S. M. NAWAZ AND M. ASLAM. *Nat. Inst. Sci., India, Proc.*, **5**, 3, *pp*. 359–367, 1939.—A beam of positive Hg-ions (600-1 000 V energy) was fired through the electron space-charge between a hot filament and anode. No change in anode current was observed on the passage of the ion beam, although some neutralization of the space-charge and consequent increase in anode current would be expected. J. B. W.

THERMO-ELECTRICITY.

See Abstract

1003B. Phenomena with fusing and evaporating of wires under very high current densities. J. Wrana.